AN ANALYSIS OF THE EFFICACY OF THE LOGISTICS COMPOSITE MODEL IN ESTIMATING MAINTENANCE MANPOWER PRODUCTIVE CAPACITY

THESIS

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AFIT/GLM/ENS/03-11

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THESIS

Presented to the Faculty

Department of Operational Sciences

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

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March 2003

AFIT/GLM/ENS/03-11

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Acknowledgments

I would like to express my sincerest appreciation to my thesis advisor, Lt Col Stephen M. Swartz. "Word up, as it were;" Lt Col Swartz kept me on track with a well timed, albeit in frequent, swift kick when I truly needed it. More importantly he provided ongoing support throughout this effort by way of expertise, patience, guidance and selflessness. Without his support this thesis, and my subsequent graduation, would not have been possible.

I would also like to thank Lt Col Brady for providing me with objective feedback as a reader on my committee.

I leaned on quite a few people and agencies throughout this effort. First I'd like to thank Mr. Frank Erdman and Mr. Mark Goldschmidt (ASC/ENMS, LCOM Branch, WPAFB) for taking me under their wings as I struggled to learn about the LCOM. I was fortunate to have two people on base that were always enthusiastic in their quest to help. Secondly, I'd like to thank Mr. Phillip Stone (ACC's LCOM office, Langley AFB VA) who provided me a copy of his Block 30 LCOM model. He was always eager to entertain questions and showed a genuine interest in my endeavor. Thirdly, I'd like to thank Col Atkinson (Cannon AFB's Maintenance Group Commander) for allowing me to gather data from the helpful personnel in his group.

Most importantly, I'd like to thank my lovely wife who proudly endured the last 18 months while I pursued my master's degree. Our journey started off with a bang as she gave birth to our wonderful son in August, and we've been running ever since. My wife and son kept my life balanced and it was refreshing to know that I could always go

home to smiling faces at the end of the day. Their patience, support, and love carried me through this effort and for that I will be forever, truly grateful.

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Abstract

The Logistics Composite Model (LCOM) is the tool of choice for many MAJCOM's (ACC, USAFE, AFMC) in determining maintenance manpower requirements. The LCOM is a simulation program capable of modeling the manpower, equipment, supplies, and facilities required to conduct aircraft maintenance activities. Manpower studies conducted with the LCOM result in manpower estimates that end up in Unit Manning Documents (UMD) as "LCOM earned," authorized positions. This research effort focuses on whether the LCOM can also be used to determine maintenance manpower's current capacity.

Three different flying units at Cannon AFB, NM were modeled to determine if the LCOM, when programmed with historical data, would imitate the actual sortie production of those units that were realized during the previous annual flying period (FY2002).

Based on the analysis and results presented, the researcher concludes that the LCOM can be a viable tool for this purpose but recommends that a standard set of "best practices" be developed and implemented by LCOM analysts to standardize the methodology and improve the reliability of results.

AN ANALYSIS OF THE EFFICACY OF THE LOGISTICS COMPOSITE MODEL IN ESTIMATING MAINTENANCE MANPOWER PRODUCTIVE CAPACITY

I. Introduction

Background

The combat readiness level of Air Force (AF) units has fallen dramatically from meeting the standard of 92% in 1996 to declining significantly below the standard to approximately 69% in 2001 (SAF/FM, 2002). The Assistant Secretary of the Air Force, Financial Management and Comptroller (SAF/FM) cites the reasons for this decline as a higher tempo, an aging fleet of aircraft, marginal resources, and a shortage of personnel due to retention & recruitment problems (SAF/FM, 2002). A key component of the combat readiness level equation, the fleet wide aircraft mission capable (MC) rate, has also declined. The MC rate is expressed as a percentage of the number of serviceable aircraft divided by the number of possessed aircraft. Specifically, the average MC rate during the period from 1988 to 1992 remained in the low 80's but this rate steadily declined reaching an average of 72.7% in 2000 (USAFE, 2002).

It is interesting to note that the decline in MC rate coincides with a drop in the percentage of skilled maintenance labor (5-level) and an increase in unskilled labor (3-level). In particular, the percentage of 5-levels in maintenance Air Force Specialty Codes (AFSC) fell from 52.8% to 44.1% while the percentage of 3-levels rose from 21.6% to 27.8% over the same period. Seven-level manning however, remained relatively stable during this period (Dahlman et.al, 2002). This is not to suggest that a reduction in the experience base of aircraft mechanics is a primary cause for the MC rate decline. It is

likely that the same factors proposed by the SAF/FM that have led to declines in combat readiness--higher tempo, an aging fleet of aircraft, marginal resources, and a shortage of personnel due to retention and recruitment problems--have also contributed to a decline in MC rates.

The AF believes it can address aging aircraft, marginal resources, and retention and recruitment problems through spending. For example, new weapon systems such as the C-17, F-22, and Joint Strike Fighter are being purchased or are under development to assume the roles currently performed by aging weapon systems. In addition, the AF hopes to mitigate problems in retention and recruitment with pay raises, targeted bonuses, and an increase in spending on military housing (SAF/FM, 2002). However, even if these problems were resolved with increased spending, the problem of high tempo would remain.

The "high tempo" the SAF/FM alludes to is the marked increase in the number of deployments without a corresponding increase in its end strength.

> "One difficulty facing the Air Force is that it has just completed the largest sustained drawdown in its 53-year history and is at its lowest strength since the late 1940s. At the same time, it is being tasked with contingency operations, peacekeeping missions, and humanitarian deployments on a scale unprecedented in peacetime." (Callander, 2000)

A high tempo created by an increase in deployments exacerbates the problems associated with an aging fleet, marginal resources, and personnel retention and recruitment. The reason problems are worsened for the AF's aging fleet and equipment is due to the additional wear and tear induced by the repeated packing, shipping, and unpacking caused by an increased deployment load. To add to the problem many

deployments end up in austere locations where aircraft and equipment are subject to marginal support facilities, temperature extremes, and local elements such as sand exposure. Retention and recruitment are also adversely impacted by high tempo as personnel work longer hours and spend more time away from home. “Taking on added responsibilities with fewer people has stressed both active duty and reserve forces and has many members looking longingly at the 9-to-5 civilian jobs” (Callander, 2000).

The problems associated with operating under a high tempo are being addressed by the implementation of the Expeditionary Aerospace Force (EAF) concept, which is designed to provide predictability and stability to Air Force units subject to deployment. Under this concept, combat units were reorganized into 10 Aerospace Expeditionary Forces (AEF), two of which, will be “on call” maintaining the capability to respond to a crisis anywhere in the world within 48 hours. The remaining eight AEFs will be at home station conducting normal peacetime operations. “The AEFs provide joint force commanders with ready and complete aerospace force packages that can be tailored to meet the spectrum of contingencies” (AF Vision 2020,2000). The two AEFs will be on call for a period of 90 days, every 15 months, which should create predictability and stability for personnel and equipment. The benefits of avoiding back-to-back deployments or extended deployment periods lasting over 90 days should provide immediate relief to aging aircraft, equipment, and retention and recruitment issues.

While the EAF concept should bring predictability and stability to the AF in terms of deployment load, there is another phenomenon the EAF will not entirely mitigate. As weapon systems and resources age, the burden placed on the personnel charged with their

upkeep also begins to increase; this increasing upkeep naturally drives manpower requirements up whether deployed or at home. The AF, recognizing this phenomenon, periodically reviews and updates manpower requirements to keep pace with this increasing burden. This typically results in manpower increases (Davis, 2002). The reality however is that manpower increases "on the books" do not equate to a body in that position (Davis, 2002). The AF is having a hard enough time recruiting and keeping the personnel it has, much less filling positions that have been recently added. Air Combat Command (ACC), for example, only fills approximately 80% of their current, funded manpower authorizations in maintenance Air Force Specialty Codes (AFSCs) (Davis, 2003). When a plus-up on the books appears it will obviously not be filled until a unit reaches 100% of its current authorizations (Davis, 2002). While the procurement of new weapon systems may alleviate the burden of aging weapon systems on the maintenance community in the long run, the short-term problem will persist.

Aging weapon systems and resources have a negative impact on the maintenance community at home or abroad but the problems do not stop there. The retention and recruitment problems the maintenance community faces are worsened by the fact that the "USAF is having no problem accessing rated trainee's, DiBattiste said, but retaining experienced fliers is a continuing difficulty" (Callander, 2002). In other words, an operational unit typically has 100% of their aircrew positions filled but with pilots that are less experienced resulting in sortie requirements that remain high (Cilento, 2002). The high tempo of peacetime home station operations is driven by the AF's need to train aircrews, and the need to train aircrews creates a need for sorties, and sorties naturally

create work for maintainers. Theoretically the relationship between the aircrew and maintainer works well when maintenance crews are manned at 100% of their authorizations while supporting aircrews manned at 100% of their authorizations. In reality the relationship is somewhat constrained due to the fact that 80% of maintainers are supporting 100% of aircrews. When aging aircraft and marginal resources are brought into the equation the picture begins to look bleak for maintainer workload, aircrew training, and aircraft readiness. In the long term, if the AF's retention and recruitment efforts prevail and manpower levels approach 100% of authorizations, then the personnel aspect which has an additive effect on declining aircraft readiness levels should be mitigated. In the short term, however, maintenance manpower issues especially at home station continue to be a problem.

Interviews with maintenance supervisors at the unit level indicate that the typical home station, peacetime workweek for maintenance personnel can be characterized as a week filled by 10 to 12 hour shifts followed by an average of 1 day of weekend work a month. This demanding work schedule can be attributed, they believe, to the high demands placed on a limited manpower pool in support of aggressive flying schedules at home (Adams, 2002; Thompson, 2002). The consensus of the maintenance supervisors interviewed is that current retention problems are due in part to the demands being placed on their maintainers at home station (Adams, 2002; Thompson, 2002).

In the near term retention and recruitment for aircraft maintainers may wind up in a "death spiral." The spiral begins with a reduced maintenance manpower pool (without a corresponding reduction in aircrews) vying to support a relatively stable number of

aircrews which leads to longer hours and weekend work for maintainers. The spiral continues as maintainers, fed up with working longer hours (increased tempo) begin to seek employment elsewhere causing a reduction in experience level (that cannot be quickly recovered with new recruits), compounding the problems associated with an already constrained manpower pool. If the stable flying requirement (demand) is not reduced to provide relief for maintainers then the spiral will seemingly continue. Obviously, reducing the flying requirement by reducing the number of aircrews is not an option, but can the number of hours that aircrews fly be reduced to more accurately match current maintenance capacity? If maintenance's capacity to produce sorties can be estimated, given a finite amount of manpower, it might be worth experimenting with a reduction of flying hours to match that capacity (for some period) to observe its affect on aircraft readiness in addition to retention and recruitment.

Problem Statement

A disconnect seems to exists between what the AF expects in terms of the demand for sorties/hours and what operational units can realistically deliver in terms of maintenance capacity. As of now, the only tool maintainers have to determine their capacity is by exploiting the experience of seasoned senior noncommissioned officers and officers. This "seat of the pants" methodology pales in comparison to the tools available to aircrews to determine training requirements. The Ready Aircrew Program (RAP), for example, is a tool that lists the sorties required to build basic and combat mission skills. Added to this number are "non-RAP" sorties that build basic pilot skills (e.g. instrument and advanced handling flights). In addition to these tools, MAJCOMs

and Numbered Air Forces (NAFs) publish a litany of instructions to prescribe weapons system and mission specific training guidance (AFI11-102, 2002). Needless to say, when maintainers meet at the negotiating table with operations to develop the annual flying hour contract it can be difficult for maintainers to articulate their instincts on what they believe is attainable. An unbiased, reliable tool that can estimate maintenance's current capacity would be extremely helpful for AF planners to objectively determine annual flying hour capabilities. The AF currently uses the Logistics Composite Model (LCOM) to estimate maintenance manpower requirements for its weapon systems in the aggregate. Through simulation, the LCOM is used to model various scenarios (e.g. wartime, peacetime, and etc) to converge on manpower numbers required to support the weapon system under study. After running various scenarios the scenario representing the largest manpower requirement (usually wartime) is determined to be the required end strength number, which is then incorporated into the Unit Manning Document (UMD) (Sandkula, 2002). For example, ACC has its own LCOM office charged primarily with estimating maintenance manpower requirements. These manpower requirements are then forwarded to the manpower office that in turn builds the UMD (Davis, 2002). The UMD is built by merging the numbers from the LCOM with additional manpower positions (determined by command standards and expert opinion) to account for overhead positions such as support and supervision (Davis, 2002). The LCOM has been used by the AF since the 1960's and is recognized as the official tool for manpower determination. If the LCOM can be used on the front end to determine manpower requirements why isn't it being used to determine maintenance's present capacity?

Research Question

The purpose of this research effort is contained in the overarching question "Can the LCOM be modified by using the actual peacetime maintenance manpower numbers, shift schedules, and parts availability numbers from an active duty squadron to assess that squadron's current maintenance capacity to execute flying schedules?" The following investigative questions must be answered first in pursuit of the answer to the overarching question.

Investigative Questions

1) Given previous year data from an F-16 wing (manpower level, flying schedule, and supply rates) will LCOM produce the same sortie rates that the wing actually attained?

2) Is the LCOM sensitive enough to produce differences in the number of sorties as manning levels are varied between authorized and assigned?

3) Is the LCOM sensitive enough to produce differences in the number of sorties as shift-scheduling philosophies are varied between 10-hour shifts/weekend work and 8-hour shifts/no weekend work?

4) Is the LCOM sensitive enough to produce differences in the number of sorties as parts availability is varied?

5) What factors (manpower, shift scheduling, or parts availability) are most influential to the LCOM in terms of sortie production?

Research Methodology

The methodology of this research revolved around the development of two separate LCOM models to simulate two Block 30 and one Block 40 F-16 squadrons at Cannon AFB NM. The F-16 models used in this thesis were actual models used by ACC to conduct manpower studies and as such, had to be modified to change their wartime flying missions into the two basic peacetime missions (air-to-air and air-to-ground). Once the models were modified to reflect peacetime missions, Cannon's annual flying data had to be incorporated into the scenario. A total of 24 different simulation scenarios were modeled to investigate the affect of varying manpower, shifts, and supply levels while holding the flying schedule constant. A baseline model was built that modeled Cannon's actual manpower, shift schedules (10 hour shifts and weekend work on Saturday), and NMCS rates. Once the baseline model was built for each squadron, successive runs were conducted (while varying each factor) and the results analyzed.

Scope and Limitations of the Research

This research was conducted in pursuit of finding a tool that can be used at the squadron level to assist maintenance planners in building realistic flying schedules. Realistic flying schedules for the purpose of this research is defined as a flying schedule that relieves some of the pressure being placed on a constrained maintenance workforce. The limitations of this research are addressed briefly in the following paragraphs. A more comprehensive discussion of each will be discussed throughout the document where appropriate.

Each F-16 LCOM model developed will only apply to that block model (i.e. Block 30 or 40) and squadron from which the historical data was obtained.

Each of the three squadron's studied at Cannon were subject to split operations at different times throughout FY2002 characterized by aircraft and personnel operating from two different locations. Due to the complexity in the task of modifying the LCOM models to model split operations the decision was made to model all sorties as if they occurred at home station using the aggregate annual numbers for each squadron. Split operations present more of a strain to the maintenance community while supporting flying operations by reducing the effective manpower in both locations. This is due to that fact that supervisory personnel are required in both locations thus requiring senior maintainers to step into supervisory positions at either location thereby reducing the overall manning numbers by an equal amount. In other words, if each squadron scheduled and accomplished a certain number of sorties while enduring split operations it is logical to assume they could meet or exceed that amount if accomplished entirely at home station.

The day-to-day manpower numbers in a unit fluctuate throughout the year as personnel arrive and leave. Capturing this level of detail in terms of fluctuating, daily manpower strengths for LCOM would be near impossible. Average manpower strengths for the period modeled will be used to conduct the simulation.

The LCOM does not model the various skill levels of maintenance personnel (i.e. 3-, 5-, and 7- Levels). The assumption in an LCOM scenario is that all personnel

modeled are fully qualified. For this reason the researcher could not capture the true essence of each unit's maintenance productive capability.

The LCOM is rarely, if at all, used to conduct tail number scheduling due its complexity. Because of this there are very few LCOM analysts who can perform this type of modeling (Stone, 2003). Tail number scheduling in the LCOM is the process of creating a schedule and assigning a specific aircraft to fill each item in that schedule. This process is similar to what occurs in a flying unit on a weekly basis. Flying units build weekly schedules with tail number assignment to help manage their fleet of aircraft by selecting aircraft purposefully to control aircraft hourly accrual for phase purposes and to schedule maintenance. The researcher attempted to perform tail number scheduling in the LCOM but lacked the experience necessary to pull it off.

The limitation in not modeling tail number scheduling is the possibility that an undue burden is placed on the simulated workforce, which may lead to an overestimation of the workforce required. This burden is created by the practice of pulling aircraft "off of the shelf" on a continuing basis to meet the flying schedule during simulation regardless of the number of aircraft that are currently broke. A weekly schedule in a flying unit is typically followed without deviation even if it means that sorties will be lost due to scheduled aircraft that are broke. This practice is necessary to maintain the health of the fleet by helping flying unit's resist the urge to pull an aircraft off of the shelf just to meet a scheduled sortie. If aircraft are broke to the point that a flying unit is having a hard time meeting the schedule then adding an aircraft to the schedule which has its own probability of failure when flown will only exacerbate the problem.

Summary

This chapter covered the background, the problem, the research question and investigative questions, the methodology, and the scope and limitations of this thesis document. The remaining four chapters of this thesis include the Literature Review, Methodology, Findings and Analysis, and Conclusions.

The literature review provides an overview of the AF's method in determining capacity (manpower) to meet flying hour needs (demand) as well as a discussion of previous research relevant to this area. This information will be used to help resolve key issues, refine the scope of this research, and lay the groundwork for the thesis methodology chapter. The methodology chapter will provide an overview of the LCOM and the process in which it was used. The findings and analysis chapter presents answers to the investigative questions and the overarching research question. The final chapter will provide findings, conclusions and recommendations for future research.

II. Literature Review

Chapter Overview

The purpose of this chapter is to provide a thorough review of literature relevant to this research effort. This chapter begins with a basic discussion of capacity and demand in civil aviation firms and the AF as service operations. The chapter will then move to a brief discussion of the tools available to help managers of service firms estimate optimal capacity vs. demands tradeoffs. A general description of the AF's manpower determination tool called the Logistics Composite Model (LCOM) will ensue. The final portion of this chapter will involve a discussion of the research relevant to this area of study. The data gleaned from the literature review will be used to resolve key issues presented in Chapter 1, which revolve around whether LCOM can be used in the field to estimate current maintenance capacity.

Capacity and Demand in Aviation: Manpower

The AF must maintain an excess capacity of resources (equipment, parts, and personnel) that would bankrupt commercial aviation firms. More specifically, commercial aviation firms must balance this capacity with consumer demand to ensure profitability whereas the AF must position its capacity for the peak demand of war (Swartz, 2002).

A commercial firm that positioned itself to handle peak demand at all times as the AF does would operate very effectively but extremely inefficiently. The firm would be able to absorb any variation in demand (effectiveness) but at the cost of an overabundance of capacity when the variance is at a low point in demand (inefficiency).

Successful firms that effectively balance capacity and demand experience cyclic patterns of excess capacity followed by insufficient capacity situations. In the aggregate, however, these firms will enjoy profitability as long as flying operations are sustained and customers are served (Swartz, 2002).

During peacetime the AF is not unlike its civilian counter part in terms the relatively stable flying schedules each face. As a result of this stability the AF should enjoy excess capacity since the flying demands during peacetime are less than the flying demands of war.

Aircraft maintenance in either the AF or a commercial firm is a service-oriented business in which the resource capacity of personnel, parts, and equipment determine the demand that can be satisfied. A limitation in any one resource constrains aircraft maintenance's productive potential. For instance, given an infinite supply of parts and equipment, but limited in manpower, an organization will only produce up to the limit of the manpower's capability. There are various tools available to industry to aid in determining the capacity required to support varying demand and visa versa.

Tools for Managing Capacity in Service Operations

There are three types of tools that managers can use to manage the capacity of service operations. The first type of tool is to experiment with the actual system and is the most basic tools used by managers. A manager who understands the business in which they manage and has gained insight into the daily operations of his business can make capacity planning decisions based on his own experience. For instance, the owner of a small dry cleaning business with an established clientele knows enough about his

business to make decisions on his own. Once the manager's plan is implemented he can observe the outcome to see the effect of his plan. As businesses increase in size and complexity, however, this type of decision-making process is often inadequate (Law and Kelton, 1992).

The second type of tool available to managers is an analytical queuing model. Analytical queuing models are mathematical equations that help managers evaluate alternative courses of action by predicting system performance. With a minimum amount of information such as the mean arrival rate and the mean service rate, the equations can generate exact characteristics of the system under study. The problem with these types of models is their limited capacity to model very complex systems (Law and Kelton, 1992).

When the characteristics of a system are too complex for actual or analytical modeling managers can use a third type of tool: computerized simulation modeling. Simulation is useful in trying to gain an insight into the various components of the system under study by running various "what-if" scenarios (Fitzsimmonds and Fitzsimmonds, 2001).

> "From a practical viewpoint, simulation is the process of designing and creating a computerized model of a real or proposed system for the purpose of conducting numerical experiments to give us a better understanding of the behavior of that system for a given set of conditions." (Kelton et al.,2002).

Aircraft maintenance is an extremely complex activity involving stochastic and deterministic issues that can only be modeled, in its entirety, through simulation. It is for this reason that the AF uses simulation modeling to make aircraft maintenance manpower decisions.

LCOM Description

Overview

"The LCOM is a stochastic discrete-event simulation of a maintenance organization used to identify optimal base-level resources." (HQACC, 2000). The LCOM was originally designed through a joint effort between the Rand Corporation and the Air Force Logistics Command in the late 1960's to provide an analysis tool for planners to "relate base-level logistics resources with each other and with sortie generating capability" (Boyle, 1990). The logistics resources modeled in the LCOM include the parts, equipment, manpower, and facilities used during a sortie generation effort.

There are currently two versions of the LCOM in use today. The "official" and most prevailing is the Air Force Management and Innovations Agency (AFMIA) version of the software (Juarez, 2002). The LCOM Program Office within AFMIA, Randolph AFB TX, maintains this version of the software. The second version of the software, developed by the Aeronautical Systems Center's (ASC's) Systems Supportability Analysis Branch, Wright-Patterson AFB OH, is the version used for this research. The two versions perform exactly the same function. The essential difference between the two versions lies in the interface with the user (Erdman, 2003).

Conducting Manpower Studies

The LCOM is versatile enough to study the interaction of several logistics factors but has evolved into one of the AF's primary methods in establishing maintenance manpower requirements. The manpower positions derived by LCOM which end up in

manpower standards and are designated by a “L” which signifies that they were “LCOM earned” (AFI 38-201, 2002). This differentiates those manpower positions that were added to the manpower standards to compensate for the fact that LCOM does not simulate personnel within an organization that are not involved in maintenance (e.g. supervisors, support personnel, and etc.) (Boyle, 1990).

Conducting a manpower study using LCOM is an iterative process, which involves manipulating the independent variables of supply, manpower, facilities, and equipment until a desired Sortie Generation Rate (SGR) is attained as outlined in the classified USAF War Mobilization Plan (WMP) (ACC F-16 C/D Final report, 1998).

During a manpower study, supply resources are adjusted in the LCOM until the command standard expressed as a Not Mission Capable for Supply (NMCS) rate is reached. In the case of the F-16 block 30 and block 40 aircraft the ACC standard is eight percent. In other words, an aircraft is expected to be non-mission capable (NMC) due to a lack of supplies (parts) only eight percent or less of the time. For this reason supplies are added and removed until the LCOM simulation results show that aircraft experienced an eight percent NMCS rate.

The most important independent variable in an LCOM-based manpower study is obviously the manpower level. Manpower levels are adjusted during each run and the resulting effect on the SGR is analyzed in addition to the utilization levels of each AFSC. If utilization levels are too low then the analyst has over estimated the manpower required and if utilization levels are too high then manpower has been underestimated.

This process continues until realistic manpower utilization levels and the SGR standard is achieved (Boyle, 1990)

Facility and equipment levels are programmed into the LCOM database and held constant at levels, which mirror the base under study.

LCOM Model Description

The LCOM software, which consists of a preprocessor program (input module), a simulation program (main module), and a postprocessor module, was written primarily using SIMSCRIPT II.5. In general Aircraft are flown, serviced, repaired, and returned to the available pool of aircraft as depicted in Figure 1. The following paragraphs are designed to provide the reader with a brief overview of the LCOM. Readers desiring more detailed information can consult The LCOM Users Manual (ASC/ENM, 1997).

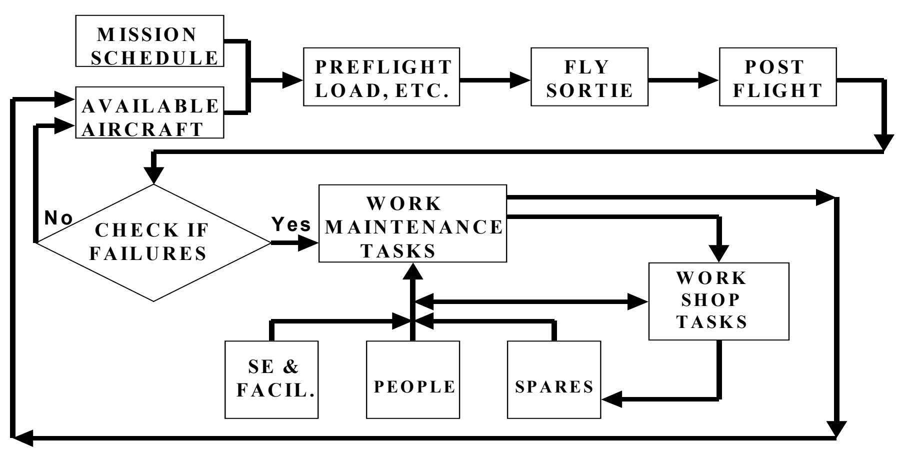

Figure 1. LCOM Simulation Logic (ASC/ENM, 1997)

Input Module

The input module constitutes the database of the simulation. This is where analysts perform the majority of the work to ensure that the scenario will represent the reality of aircraft maintenance. The database includes input data called "Forms." The most commonly used forms are described in the following paragraphs.

Form 15 is the Resource Definitions database designed to define the aircraft, manpower (by AFSC), parts, facilities and equipment that the analyst desires to model during simulation (ASC/ENM, 1997).

Form 20 is the Attribute Definitions database designed to define the characteristic of an aircraft or the system. Typical attributes include either a time accumulating attribute or an incrementing attribute (ASC/ENM, 1997).

Form 25 is the Task Definitions database used to define each task used during the simulation (ASC/ENM, 1997).

Form 30 is the Task Networks database, which provides the intricate detail of the sequencing of task performance during simulation. Examples of the types of tasks in this database are: scheduled maintenance, unscheduled maintenance, and "mainline tasks" such as reconfiguring aircraft and preflight inspections (ASC/ENM, 1997).

Form 35 is the Clock Decrements database used to define the interval (e.g. days) that maintenance actions or resource failures will be clocked (ASC/ENM, 1997).

Form 40 is the Empirical Distribution Definitions database that can be used in to define the parameters of entries in Forms 15, 20, 25, or 75 (ASC/ENM, 1997).

Form 45 is the Shift Change Policy database used to define shift durations, shift repetitions, and shift authorizations (ASC/ENM, 1997).

Form 50 is the Priority Specification Definitions database designed to assign a priority level of 1, 2, or 3 to tasks for resource prioritization (ASC/ENM, 1997).

From 55 is the Mission/Activity Definitions database designed to list the activities (e.g. phase inspections) or aircraft missions (e.g. air-to-air) utilized during the simulation (ASC/ENM, 1997).

Form 60 is the Search Pattern Definitions database designed to list the specific sequence that the simulation will follow when searching for aircraft to assign to missions or activities. This database is written so that a search is conducted for the aircraft that presents the least amount of reconfiguration to meet the next sortie (ASC/ENM, 1997).

Form 75 is the Sortie Generation Data database that defines all of the mission and activity requirements that the analyst wishes to model (ASC/ENM, 1997).

The input module, once run, prepares an initialization file, which compiles all of the data from the forms necessary to describe the maintenance environment. An exogenous file is also created which contains all of the information necessary to execute the flying schedule and maintenance activities. These files are used by the main module to run the simulation (Boyle, 1990).

Main Module

The main module contains the software required to execute the scenario and produces the reports as requested by the user. Reports are requested through the use of a "change card file" at the beginning of the simulation. The change card file is also used to

specify the length of the simulation and is used to vary the level of resources during subsequent runs.

Post Processor Module

The post processor module produces summary statistics for the following categories: operations (e.g. sorties flown), activities (e.g. number of aircraft phases), personnel (e.g. man hours used), supply (e.g. average NMCS rate), shop repair (e.g. number of items repaired), AGE (e.g. AGE used), aircraft (e.g. number of aircraft days available), and facilities (e.g. facilities used) (Boyle, 1990).

Relevant Research

The relevant research to this thesis can be broken down into three categories. The first category includes the research that examined LCOM's ability to perform other forms of analysis such as its ability to measure the effectiveness of various flying schedules (Boyd and Toy, 1975) and its ability to project the monthly sortie effectiveness of an F-15 wing (Davis and Smith, 1977). The second category of research includes a recent (2002) RAND corporation report that examined LCOM's ability to estimate manpower requirements. The third category of research examines productivity as a function of skill and explores incorporating skill level (i.e. 3-,5-,and 7-level) into LCOM. The following paragraphs describe this research and their conclusions.

LCOM's Ability to Perform Other forms of Analysis

In 1975, Boyd and Toy conducted thesis research to examine LCOM's ability to "measure the effectiveness of aircraft flying schedules" (Boyd and Toy, 1975). Their study involved using the previous version of LCOM to simulate 26 weekly flying

schedules of F-4E wings. Manpower during their study was held to a level that reflected the wing's authorizations. Boyd and Toy's handling of aircraft parts availability was not discussed in write-up. Boyd and Toy concluded that the LCOM was not an accurate tool that could be used to predict the scheduling effectiveness on a weekly basis but concluded that the LCOM may provide more accuracy when looking at the 26-week period in the aggregate (Boyd and Toy, 1975). Boyd and Toy recommended that monthly schedules be explored next to help narrow the time required to gain scheduling accuracy.

Davis and Smith conducted thesis research in 1977 as a follow-on to Boyd and Toy's research to examine the capability of the LCOM to predict the monthly sortie effectiveness of an F-15 wing. Their study involved using the LCOM to input monthly maintenance and flying schedules from a previous six month period from the 1 TFW at Langley AFB VA to determine if the LCOM accurately predicted the number of sorties the wing actually generated during that period. Manpower for their study was held at the authorized level for the 1 TFW; however, their handling of aircraft parts availability was not mentioned. Davis and Smith's concluded that the LCOM could not be used to accurately predict the actual sortie scheduling effectiveness of an F-15 wing and that the LCOM would not be suitable to as a tool for evaluating alternative monthly flying and maintenance schedules. Davis and Smith mentioned that a possible reason for LCOM's lack of accuracy in their study might have been due to the newness of the F-15 as a weapons system during that time and the fact that several new F-15's were delivered to the wing during the period of their study.

LCOM: Manpower Estimation

A recent RAND report (Dahlman et. al., 2002) published in April of 2002 discusses the AF's methods in setting maintenance manpower requirements. The RAND study not only discovered problems with LCOM but also discovered several problems in the AF's methodology regarding issues that serve as critical assumptions before conducting an LCOM study. The following paragraphs describe some of the recommendations to the problems described in the RAND report.

The First recommendation is for LCOM studies to begin including more realistic scenarios characterized by lengthy deployments and split ops with considerable home station resource shortages and time consuming peacetime tasks coupled with providing enough sorties to absorb junior pilots. RAND believes that this scenario could be even more stressful for the maintenance force than the wartime scenarios currently modeled (Dahlman et.al., 2002).

Another recommendation the RAND report provides is to allow LCOM analysts the ability to model actual field practices as opposed to written policy. One such example is requiring analysts to hold NMCS rates at the command standard rather than letting them program actual NMCS rates into the scenario. Rand believes that this will allow analysts to examine the manpower implications of this phenomenon (Dahlman et. al., 2002).

A third recommendation the RAND report makes is for LCOM analysts to introduce skill level mixtures and on-the-job training (OJT) processes into the scenario. The LCOM models currently used for manpower studies do not have the capability of

utilizing varying skill level mixtures. In other words, the manpower in LCOM's resource pools is assumed to be fully qualified. This assumption poses a problem when the final manpower numbers end up in manning documents because the reality of aircraft maintenance is that at approximately 20 percent of authorized maintenance manpower is filled by unqualified 3-levels who cannot perform 100 percent of the tasks required of them (Dahlman et. al, 2002). In addition these 3-levels require OJT, which takes a fully qualified 5- or 7-level to train them, in essence further reducing the effective manpower available on the flightline.

A final recommendation from the RAND report is for the AF to evaluate the relevance of the Man-hour Availability Factor (MAF) published in AFMAN 38-201, Vol 2. The MAF is "the average number of man-hours per month an assigned individual is available to do primary duties" and accounts for the amount of time a person is away from his primary duties by considering activities such as leave, medical, Permanent Change of Station (PCS) related issues, organizational duties, education and training, and etc (AFMAN 38-201, 2002). Since the LCOM does not models leave and etc. these MAF's are utilized extensively to translate the raw manpower numbers derived from a manpower study into actual numbers that end up in manpower standards as "LCOM earned" positions. For example, the MAF for sustained wartime operations of 1.461 is multiplied against the numbers generated by an LCOM study. If an LCOM study determines that 55 crew chiefs are required to support a weapon system this number is multiplied by the MAF of 1.461 to generate the final number (55 x 1.461 = 80.355 crew chiefs). The RAND report believes that the MAF, which applies to personnel in all

AFSC's, may not be accurate when looking specifically at personnel in the maintenance AFSC's.

Manpower Productivity

In 1979, French and Steele published research designed to relate AF skill levels (3-, 5-, and 7-level) to productivity factors. Their conclusion was that there is a significant difference between what we should expect in terms of productivity of 3-, 5-, and 7-level personnel in a maintenance organization. They developed the following factors (Table 1) to equate each skill level to a productivity factor:

Table 1. Skill Level Productivity Factors (French and Steele, 1979)

7-Level	1.155
5-Level	1.000
3-Level	0.869

By using a 5-level as the referent skill level, French and Steele concluded that a 3-level should be expected to produce approximately 13 percent less than the referent 5-level and approximately 15.5 percent less than a 7-level (French and Steele, 1979).

In 1981, Garcia and Racher published research designed to incorporate skill level effects into the LCOM. Garcia and Racher's conclusions included creating two separate manpower pools in LCOM; one qualified pool (5-, and 7-levels) and one unqualified pool (3-levels). In addition to the 2 separate manpower pools a separate task of networks were developed to account for the slower speed of unqualified technicians. Garcia and Racher tested these recommendations in the LCOM and determined that there was a strong correlation between productivity and skill level mixture (Garcia and Racher, 1981).

Summary

The purpose of this chapter was to provide a thorough review of literature relevant to this research effort. This chapter began with a basic discussion of capacity and demand in civil aviation firms and the AF as service operations. The discussion moved to the tools available to help managers of service firms estimate optimal capacity vs. demands tradeoffs and a general description of the AF's manpower determination tool called the Logistics Composite Model (LCOM). The final portion of this chapter covered the research relevant to this area of study. Chapter #3 will cover the methodology used in answering the overarching research question of this thesis and its subordinating investigative questions.

III. Methodology

Chapter Overview

The purpose of this chapter is to provide a description of the quantitative methodology used to answer the research question presented in Chapter 1. In general the research is designed to analyze the efficacy of the LCOM in estimating maintenance manpower productive capacity. The chapter will begin with a discussion of the subjects and data used to conduct the research. The chapter will then proceed through a discussion of how the two different F-16 models were modified to reflect the characteristics (manpower, aircraft, supply, and flying schedule data) of three Cannon F-16 squadrons for FY2002. The discussion will then move to a description of the process used to create the 24 different models used to conduct this research. The chapter will conclude with a description of the statistical methods used to analyze the research results.

Test Subjects

The subject population of this research includes two active duty squadrons of Block 30 F-16's and one active duty squadron of Block 40 F-16's from Cannon AFB NM. Due to the unique deployment schedules and annual flying requirements of F-16 squadrons in the AF the researcher sought to conduct research on F-16 units that experienced only home station flying activities. Unfortunately, during FY2002, none of the operational F-16 units were fortunate enough to avoid deployments. Due to this fact Cannon AFB NM was selected as the basis of this study essentially due to their responsiveness in providing all the data necessary vital to this research effort.

Data

The data collected for this research effort falls into one of four categories: manpower, aircraft, supply, and flying schedule. The form of this data is discussed in the following paragraphs; however, the discussion of the use of this data will be contained in the section regarding the LCOM model development.

Manpower

Manpower information comes in various forms across the AF depending on whether the information pertains to authorized or assigned manpower. Authorized manpower is the easiest information to come by as it is developed by a respective unit's MAJCOM and changes infrequently. This data can be attained from either the MAJCOM or the base. Accurate assigned manpower information, on the other hand, is more difficult to attain since it constantly changes as personnel separate and PCS coupled with the fact that manpower assignments at the base level involve a certain amount of "horse-trading" between different units (Hogue, 2002). This data is available, in accurate form, only at the base level.

Authorized

The Authorized manpower information used in the research came in the form of a Unit Manning Document provided by Cannon's personnel office. Five different UMD's were used to collect the data for this research; one from each of the flying units (522^{nd}, 523^{rd},and 524^{th} Aircraft Maintenance Units (AMUs)) and one from each of the backshop squadrons (Component Maintenance Squadron (CMS)-formerly know as the Component Repair Squadron (CRS), and the Equipment Maintenance Squadron (EMS)).

Fortunately, Cannon's personnel office still had the manpower authorizations that applied to these units before they restructured under the new wing structure at the end of FY2002. The new wing structure moved all maintenance activities under a maintenance group. The most noticeable change to maintenance manpower positions, in the flying units, was the movement of aircraft phase inspections and the associated manpower to EMS.

Assigned

The assigned manpower information was compiled by Cannon's manpower and assumed to be current and complete for all AFSC's except for a limitation in crew chief manning. Unfortunately, the office did not carry historical numbers but did provide the current assigned manpower numbers for each of the 5 units. Since maintenance manpower numbers AF wide have remained relatively stable over the last two years the researcher believes it is reasonable to assume that the current manpower numbers at Cannon are similar to the numbers they possessed during FY2002 (Davis, 2002).

Aircraft

There are essentially two categories of aircraft assignments in an operational unit. The first category of aircraft is called Chargeable Primary Authorized Aircraft (PAA). PAA is the number of aircraft authorized by Headquarters, United States Air Force (HQ USAF) and is used as the basis for determining manpower authorizations and flying hour program numbers. The second category of aircraft is called Backup Aircraft Inventory (BAI). BAI are used to backfill PAA that are in Depot maintenance and etc (USAFEI 11-101, 1995). The numbers provided by Cannon reflect a PAA breakdown per squadron, per month.

Supply

The supply information was provided by the wing's analysis office in the form of an Excel spreadsheet, which is a collection of statistics compiled on a month-by-month basis and reported to the MAJCOM. The statistic of focus for this research regarding supply information was the NMCS rates that the each flying unit experienced throughout the year.

Flying Schedule

Flying schedule information for each of the flying units was also taken from the wing's monthly analysis spreadsheet. This research focused on the number of scheduled flights vs. the number of flights actually flown and the resultant sortie generation rate (expressed as a ratio of the number of sorties schedules divided by the number actually flown).

Development of the LCOM model

The following paragraphs describe the methodology used to transform each wartime F-16 model into Cannon's peacetime mission. The Block 30 and 40 models are similar so the discussion applies to both models unless specified otherwise. The modifications that needed to be made fall into the four categories mentioned previously in the data section. The first category involves modifications to each model to incorporate Cannon's authorized or assigned manpower numbers and shift schedule. The second category involves incorporating Cannon's aircraft numbers. The third category involves modifications that incorporated Cannon's historical NMCS rates. And the final category involves modifying the model to accommodate flying schedule changes. In

some cases the modifications were necessary to change the scenario from wartime to peacetime and in others, the modifications were necessary to incorporate Cannon's historical data. These will be specified, where applicable, in the following paragraphs. Appendices B and C provide examples of the changes made to Forms 15 through 75 or the changecards, respectively. Due to the length of the data (over 400 pages each) complete copies of each model are not included in the Appendices, however, the complete models that were used for this research can be obtained from AFIT/ENS.

Manpower

The data provided for crew chief manning did not reflect crew chief manning assignments before they were combined under EMS. The researcher attempted to contact the supervisors of the respective flying units to attain manpower number by interview but ran into roadblocks stemming from the fact that each unit had recently undergone a management turnover designed to "shake things up" (Bove, 2002). To avoid using interview data from some sources and estimating where interview data was not available the researcher compensated by using a proportional assignment of existing manpower based on authorizations. In short, each flying unit's crew chief authorizations for both the flightline and phase were converted into a percentage of total authorizations. These percentages were then applied to the assigned manpower numbers of crew chiefs that still worked either flightline or phase under the new wing alignment. For example, if eight percent of the total authorizations of crew chiefs were authorized to work in the 522's phase dock before the reorganization then eight percent of the total assigned crew chiefs were allocated to the phase dock for simulation purposes. Appendix A contains the

spreadsheets used for these conversions and Appendix B provides an example of the changecards used to allocate manpower.

As briefly discussed in the previous chapter, raw manpower numbers that are generated from an LCOM manpower study are converted using a MAF to account for time spent away from work. The MAF used to convert the current UMD numbers from the sustained wartime LCOM scenario was 1.461. In order to convert the UMD number supplied by Cannon into a number suitable for use in LCOM, the reciprocal of 1.461 was used. For example, if a unit's UMD shows that 100 crew chiefs are either authorized or assigned, a factor of 1/1.461 was multiplied to this number to attain the number that would be modeled in LCOM. So the resultant manpower modeled in LCOM would be derived as follows: 1/1.461 x 100 = 68.45, or 69 crew chiefs would be used to run the scenario. Appendix A contains a listing of the numbers used to run the LCOM scenarios for each flying unit.

A problem was confronted on how to model the manpower distribution for the manpower contained in either EMS or CMS as scenarios were run for each individual flying unit. These manpower positions are considered a pooled resource that can be used for any asset requiring work regardless of the squadron from which it came. For instance, how should the nine personnel authorized in the hydraulic shop (CMS) be modeled in each simulation scenario? One solution is to divide the authorizations by three, thereby allocating 1/3 of the total manpower to each of the flying units. This solution would possibly underestimate the manpower actually available for any one squadron's assets and would pose problems in the LCOM where minimum manning

requirements are specified for certain tasks. Another solution is to use the total authorization of each backshop AFSC for simulation purposes. This solution would possibly overestimate the manpower available for any one squadron's assets. Since the true manpower contribution from pooled AFSC's supporting several flying units is impossible to assess the researcher decided to use 50 percent of the authorized or assigned (depending on the simulation scenario) manpower numbers for simulation purposes.

There were two exceptions to the 50 percent manpower distribution process. The first exception was CMS's fuel shop. Since the fuel shop at an F-16 base is commonly very busy with F-16's from all squadrons the researcher allocated 1/3 of the authorized or assigned manpower to each unit during the scenario. The same procedure was used for the structural shop ("sheet metal"). Appendix B contains an example of a changecard utilized for each simulation scenario.

Finally, the wartime models were written to model two, 12 hours shifts seven days a week. In a peacetime environment shifts are usually split into three, eight-hour shifts with one day of weekend work. The models had to be changed to reflect this change of assumption. Appendix C, Form 40, provides an example of this change.

Aircraft

Since LCOM manpower studies are based on PAA figures, the researcher used each squadron's PAA average annual figures to conduct each study. According to Cannon's spreadsheets the 522nd, 523rd, and the 524th had an average of approximately 18, 17, and 24 PAA, respectively, throughout FY2002.

Supply

Average monthly NMCS rates will be used instead of parts actually consumed throughout the year. The LCOM stochastically chooses aircraft systems failures and repair times to determine unscheduled maintenance tasks. Each failure prompts the LCOM to run through a predefined task network that mimics maintenance on the flightline. To mimic flightline operations the LCOM continues through the task network until the probable cause of the malfunction is randomly chosen. This cause typically results in a demand placed on supply to facilitate the removal and replacement of a part to fix the problem. Since the LCOM cannot be modified to model the actual maintenance tasks that occurred during FY 2002 it will not be able to model actual parts consumption. In lieu of modeling parts consumption for Cannon, NMCS rates were used instead. To effectively reflect the demand for supplies at Cannon, the numbers of parts available in supply "on the shelf" were varied until the simulation output reflected similar NMCS rates. Appendix B provides an example of the changecard used to implement these changes.

Flying schedule

There are three basic methods used to run the LCOM for manpower studies: fly-when-ready, composite, and scheduled. The following paragraphs briefly describe each method.

Typical LCOM manpower studies involve flying under a "wartime" scenario to simulate the worst-case scenario. This scenario is modeled in the LCOM by running the simulation under fly-when-ready guidance. In other words, all available aircraft will fly,

land, undergo maintenance (if necessary), get serviced, and returned to the pool of available aircraft to fly again. This type of scenario is incidentally the easiest to simulate, but too far from the reality of home station operations.

The second is a composite mission where a combination of different aircraft types can be modeled (e.g. F-15 and F-16) for the same mission.

The final method is by building a flying schedule. Under this scenario the LCOM will simulate the number of sorties and turn scheme specified by pulling aircraft from the available pool of aircraft (24 in the case of a 24 PAA squadron). Under this scenario all scheduled maintenance actions (e.g. phase inspections and aircraft washes) for the Block 40 model are scheduled by the analyst on Form 75 based on the frequency of occurrence at the unit under study. The Block 30 model uses attributes to determine when scheduled maintenance is performed. For example, the Block 30 model uses an attribute named PHASEDUE to track the hours accrued on each aircraft. After each sortie, the hourly value is checked to see if the phase inspection is due based on a 300 hourly requirement (Stone, 2003). Other scheduled maintenance tasks follow the same logic in the Block 30 model based on either an hourly or calendar clock established by maintenance requirements in the applicable -06 Technical Order (TO).

This research utilized the final method discussed above where the flying schedule (in terms of number of sorties and turn scheme) for each unit was input into the LCOM. The fly-when-ready approach first discussed would not capture reality close enough for this research. The second approach, composite scheduling, did not apply. The final method was well suited to model to determine capabilities based on alternative flying

schedules. The following paragraphs provide a discussion of the methodology used to incorporate Cannon's flying schedule into LOCM.

Ideally, the most accurate way to model Cannon's flying activity for FY2002 would be to build a flying schedule that matched Cannon's day–to-day flying activity. This type of scenario would have been extremely tedious to perform since it would have involved making a separate entry for each flying day for the entire year. In addition, it would have required modeling hot pits, exercises, and split operations. To compensate for the lack of precision in the scheduling process the researcher decided to use each flying unit's sortie utilization rate (UTEs). The sortie UTE is expressed as the number of sorties flown per aircraft per month and is usually spoken of in terms of an annual figure. In other words, a squadron with 24 PAA that must fly a UTE of 18, means that the unit must fly 5184 sorties for the year (24 aircraft x 18 UTE x 12 months = 5184 sorties). This figure is a programmed UTE rate; scheduled UTE rate figures will be higher to compensate for historical attrition rates (e.g. weather, maintenance cancels). UTEs are goals expressed by each MAJCOM's headquarters for each weapon system and is a function of aircrew training needs and aircraft availability issues such as depot maintenance (USAFEI 11-101, 1995).

For the purposes of this research, the annual scheduled sortie numbers for each squadron was used to determine the scheduled sortie UTE and then converted into a standard daily flying requirement. The following discussion describes this process for each flying unit.

522nd Flying Schedule

The 522nd scheduled and flew 4489 and 3922 sorties, respectively, during FY2002 for a 87.37 percent SGR. In order to convert the aggregate scheduled number into a flying schedule the scheduled sortie number was divided by 12 (the number of months in a year).

4489/12 = 374 sorties per month

Once the number of sorties per month was determined a schedule had to be built that reflected what each unit expects it can fly on a recurring basis. For instance, the schedulers in the 522nd expect to be able to fly a 10 front Monday through Friday. Monday through Thursday they expect to fly a 10 turn 8 and on Fridays a single go (McGowan, 2003). This equated to a scheduled sortie number for LCOM simulation purposes of 4484; four short of what the unit actually scheduled.

523rd Flying Schedule

The 523rd scheduled and flew 4092 and 3778 sorties, respectively, during FY2002 for a 92.33 percent SGR. In order to convert the aggregate scheduled number into a flying schedule the scheduled sortie number was divided by 12 (the number of months in a year).

4092/12 = 341 sorties per month

The schedulers in the 523rd expect to be able to fly similar numbers as the 522nd so the same methodology to construct a schedule that could be written to LCOM was used (Cochran, 2003). Since the 523rd flew less than the 522nd and they had fewer

aircraft the schedule was paired back a bit to attain a similar scheduled number that the 523rd actually scheduled. In the end, 4074 sorties were scheduled in the LOCM scenario.

524th Flying Schedule

The 524th scheduled and flew 5682 and 5179 sorties, respectively, during FY2002 for a 91.15 percent SGR. In order to convert the aggregate scheduled number into a flying schedule the scheduled sortie number was divided by 12 (the number of months in a year).

5682/12 = 475 sorties per month

The schedulers in the 524th expect to be able to fly a 12 front on Monday through Friday with two go's each day. In order to converge on a schedule in the LCOM which will equate to similar numbers as what the 524th actually scheduled, a 12 turn 12 was simulated Monday through Thursday and a 12 turn 6 was scheduled on Friday. In the end, 5672 sorties were scheduled in the LOCM scenario.

Modeling Techniques

After the three basic models for each flying unit had been modified to reflect peacetime missions and flying schedules, the process of running various iterations for each of the three models ensued. The iterative techniques involved four groups of scenarios, which are depicted in Table 2. The first group involved varying manpower numbers to reflect Cannon's authorized or assigned end strength while keeping shifts and supply numbers the same as the baseline. The second group involved varying manpower numbers again, however, shift philosophies were modified to reflect no overtime or weekend work. Supplies were kept the same as the baseline. The third group also

involved varying manning numbers, however, supplies were increased and shifts were reverted back to the use of overtime and weekends. The fourth group involved manning variations while modifying shift philosophy and increasing the number of parts. The iterative techniques (eight total) were used for each flying unit (522^{nd}, 523^{rd}, 524^{th}), which resulted in 24 different scenarios. The following paragraphs discuss the initial conditions, initialization seed values, warm up period, and the basic techniques used to run each scenario. Since the eight iterative techniques for each unit was the same the following discussion applies to them all.

Table 2. Modeling Scenario Matrix

Shift Philosophy	**Manpower**	**Parts Availability Baseline (B)**	**Parts Availability Extra (U)**
Overtime (O)	**Assigned (AS)** **Authorized (AU)**	**Group 1** AS/O/B AU/O/B	**Group 3** AS/O/U AU/O/U
Normal (N)	**Assigned (AS)** **Authorized (AU)**	**Group 2** AS/N/B AU/N/B	**Group 4** AS/N/U AU/N/U

Initial Conditions

At the beginning of each simulation run each aircraft was assumed to be mission capable and supplies were on the shelf in the numbers specified. The only preconditions the researcher modeled was to pre-configure aircraft for flight based on each unit's pending flying schedule. The practice of pre-configuring aircraft is common practice in flying units. The pre-configurations for each model were handled by adding this information to the changecard prior to running each scenario an example of which is in Appendix B.

SEEDS

The ASC LCOM program used for this research provides the capability to establish initialization seeds for production runs. To reduce the variability introduced by using a random draw of initialization seeds, 75 seed values were generated and used for each of the 24 scenarios. Specifically, replications 1 through 75 for each of the 24 scenarios started at the same successive seed value as presented in Appendix E.

Warm up

A warm up of 30 days was selected to overcome the initialization bias introduced by having a fleet of servable aircraft and all supplies on hand at the beginning of each simulation. According to Law and Kelton, the "simplest and most general technique" to determine an appropriate warm up period is to graph the output of the simulation to determine where the graph "flattens out" (1992). In other words, the graph should display an obvious transient period at the beginning of the simulation period due to input conditions that don't mirror reality followed by the graph settling down. Figures 2 through 4 display the average daily sorties produced after running 75 replications of the baseline models for the 522nd, 523rd, and the 524th, respectively. The 522nd and the 523rd simulation models appear to reach steady state after approximately one week, however, the 524th appears to reach steady state after a month. The apparent drop in sortie out put for the 522nd and the 523rd at around the 210-day point can be attributed to scheduled maintenance (one aircraft enters full paint) scheduled for that time. The researcher believes that a 30-day warm up period was sufficient to overcome initialization bias.

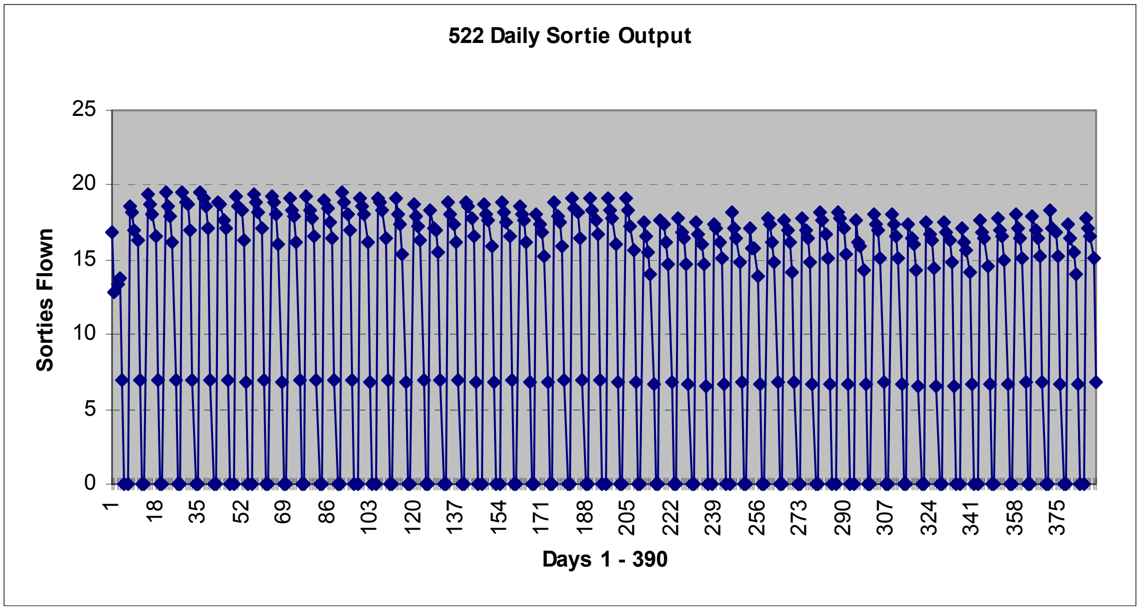

Figure 2. 522nd Warmup Period

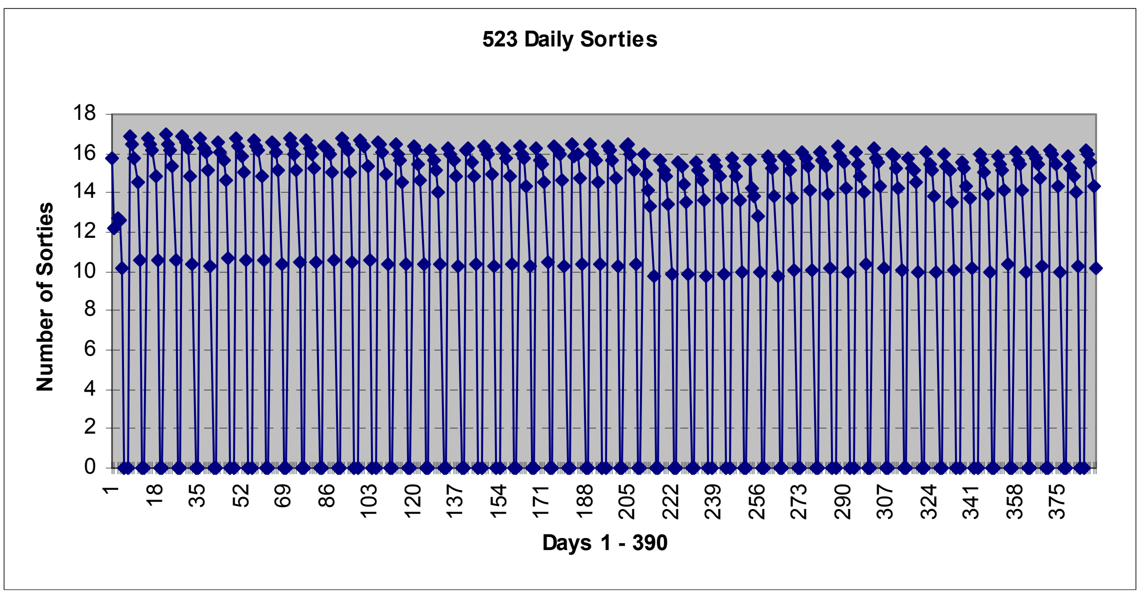

Figure 3. 523rd Warm up Period

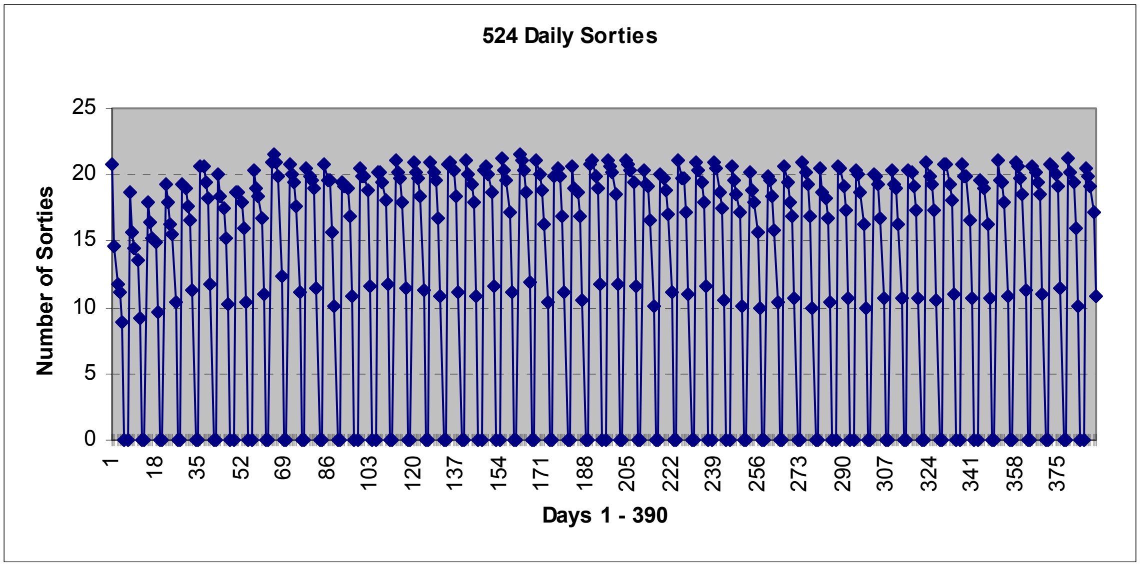

Figure 4. 524th Warm up Period

Actual Manning Scenario: Baseline (Group 1)

The first simulation conducted for each squadron was to establish a baseline simulation scenario that incorporated Cannon's actual manning, shifts, and NMCS rates. This meant that the simulation scenario should reflect actual manpower numbers dispersed over three shifts of maintenance on Monday through Friday and one shift on Saturday. Day shift (0800-1600) and swing shift (1600-2400) had the largest proportion of the total maintenance manpower allocated to them with mid shift (2400-0800) comprising the balance of the manpower. One limitation to this research involved how to model 10-hour shifts in the LCOM (Cannon maintainers currently work a standard 10 hour shift). When modeling shifts in the LCOM, the 24-hour day must be split such that the sum of the shifts equals 24 hours. To overcome this limitation the researcher elected to allow overtime of two hours for personnel, which allowed maintenance personnel to continue working on tasks instead of being preempted at the end of a shift. The

researcher believes this is comes closer to modeling 10-hour shifts for simulation purposes. This manpower allocation reflects Cannon's actual maintenance practices throughout FY2002. Supply information was varied until the actual NMCS rates for each unit were attained. The results from this simulation scenario were used as a baseline for comparison as manning and shift alternatives were explored during alternative runs.

Authorized Manning Scenario (Group 1)

The second simulation involved incorporating the authorized manning for each squadron into the LCOM scenario while leaving everything else the same.

Actual Manning with No Overtime and Baseline Parts (Group 2)

The third simulation scenario involved modeling assigned manning numbers and incorporating the shift policy as published in AFI21-101_ACCSUP1_INT which states that maintenance will "limit third-shift manning to small servicing crews, essential maintenance personnel, and weapons load training" (HQ ACC, 2003). In addition, the instruction states "maintenance personnel will be scheduled for duty based on a 40-hour workweek" (HQ ACC, 2003). In lieu of this policy the researcher chose to model shifts which reflect the spirit of AFI21-101 by eliminating mid shift, reducing shifts to eight-hours, and eliminating weekend work. Eliminating weekend work is not stated in the instruction; however, the assumption is that working weekends is not desirable. Manning previously allocated to mid shift was redistributed to the remaining two shifts and supply numbers were unchanged.

Authorized Manning with No Overtime and Baseline Parts (Group 2)

The fourth simulation scenario involved modeling authorized manning numbers and incorporating the reduced shift policy used in the third scenario while utilizing the parts established by the baseline model.

Actual Manning with Overtime and More Parts (Group 3)

The fifth simulation scenario involved modeling assigned manning numbers working the shifts used in the baseline model. Parts were increased to a level established in Group 4's scenarios.

Authorized Manning with Overtime and More Parts (Group 3)

The sixth simulation scenario involved modeling authorized manning numbers working the shifts used in the baseline model. Parts were increased to a level established in Group 4's scenarios.

Actual Manning with No Overtime and More Parts (Group 4)

The seventh simulation scenario involved modeling actual manning numbers and working them under reduced man-hours while increasing the number of supplies to reach the actual NMCS rate that was realized during FY2002. This scenario was used as the parts baseline for Groups 3 and 4 since it represents the most constraining in terms of manpower and shift philosophy.

Authorized Manning with No Overtime and More Parts (Group 4)

The eighth simulation scenario involved modeling authorized manning numbers and working them under reduced man-hours while increasing the number of supplies as discussed in the seventh scenario.

Statistical Methodology

Once the 24 different scenarios were executed and the SGR and NMCS data collected, a methodology had to be developed to analyze the results and draw conclusions. The analysis, which will be covered in detail in the next chapter, was separated into three portions. The first portion deals with validating the baseline model's ability to reflect what actually occurred in each unit during FY2002. This analysis will use hypothesis testing to determine whether the SGR of the baseline model is statistically equivalent to Cannon's actual SGR. The second portion of the analysis uses factor analysis to determine if any of the factors (manpower, shifts, or parts availability) affect the number of sorties produced during simulation. The final portion of the analysis will use paired t-tests to determine which factors influence the simulation model's sortie output.

Summary

This chapter covered the methodology used to construct the simulation scenarios used in this research effort. The chapter began with a discussion of the test subjects and data used to conduct the research. The chapter then addressed the modification of the Block 30 and Block 40 models (acquired from ACC) to incorporate Cannon's FY2002 characteristics. The chapter then discussed the iterative process utilized to model the 18 different scenarios used for this research. The chapter concluded with a brief description of the statistical methodology used to analyze results and draw conclusions. Chapter 4 will discuss, in detail, the analysis and results of the research.

IV. Analysis and Results

Chapter Overview

The purpose of this chapter is to report the results and analysis of the simulation scenarios conducted according to the methodology discussed in the previous chapter. The results and analysis presented in this chapter are broken down into four areas. The first area simply presents the results of the simulation runs from each of the 24 different scenarios. The second area is dedicated to validating the baseline models for each of the flying units. This will entail determining whether the baseline simulation scenarios, which modeled Cannon's actual FY2002 maintenance parameters, are statistically equivalent to what Cannon realized during the period. The baseline models that pass the first test will then move into the third area of analysis. The third area will concern itself with an analysis of the 24 scenarios to determine if any of the factors (manpower, shifts, or parts availability) has an affect on LCOM's sortie producing capability. A multifactor analysis of variance (ANOVA) will be used to perform the analysis. Assuming that the ANOVA shows that at least one factor has an effect, the fourth area of analysis will use difference of means tests to determine which factors produced different sortie numbers in LCOM. The chapter will conclude with a restatement of the investigative questions presented in Chapter #1 followed by conclusions to those questions in light of the analysis.

Results of Simulation Scenarios

The following paragraph explains the coding used to abbreviate the simulation scenarios found in throughout this document. Each simulation scenario is identified by

four parameters separated by a "/". The first parameter identifies the squadron (i.e. 522 or 523rd). The second parameter identifies whether the manpower modeled was authorized (AU) or assigned (AS). The third parameter identifies whether the shifts modeled were actual (O depicting overtime; 10 hours and Saturday weekend work) or as per command guidance (N depicting 8 hours and no weekends). The fourth parameter identifies whether the number of parts modeled are equal to the amount of parts developed under the baseline scenario (B) or unlimited (U). For example, 522/AS/O/B, means that the scenario modeled the 522nd with their FY2002 assigned manning (AS), shift policy (O), and the baseline parts availability (used to recreate their FY2002 NMCS rate).

Tables 3 through 5 display the results for the simulation scenarios for each respective squadron. A more detailed analysis will be included later in the chapter; however, a general discussion based on inspection will ensue.

522nd Results

The first four rows of Table 3 (522nd results) show the results from the scenarios where the number of parts was established by the baseline model (522/AS/O/B) and left alone while manpower was adjusted from assigned to authorized and shifts were varied between overtime and normal. When comparing the first row to the second row where manpower was raised from assigned to authorized there appears to be an increase in the number of sorties flown. The slight increase in NMCS rate from the baseline model to the authorized manning model is statistically insignificant. The third and fourth rows display the results after reducing shift hours to eight and eliminating weekend work while

still modeling the parts established by the baseline model. Note the significant decrease in the sortie output coupled with a significant increase in the respective NMCS rates of these two scenarios when compared to the first two scenarios. The significant increase in the NMCS rates can be directly attributed to the reduction in backshop personnel productivity (reduced shifts). This increase in the NMCS rate directly contributes to the decline in sortie production.

The last four rows of Table 3 show the results from the scenarios where the number of parts was established by a baseline model, which modeled eight-hour shifts and no weekend work (522/AS/N/U). A “U” was used as a symbol for these scenarios since virtually an unlimited number of parts had to be modeled (over 25 of each part) to reach the FY2002 NMCS rate of that squadron. Note the apparent increase in sorties of these four scenarios when compared to their counter part in the first four scenarios. Also note the significant reduction in the NMCS rate (at or near zero) at these parts levels when shifts are raised to 10 hours and weekend work. Finally, note within groups, as manpower is varied between assigned and authorized, there is an apparent increase in sorties produced.

Table 3. 522nd LCOM Results

Squadron & Scenario	Sorties Scheduled	Avg Sorties Flown	Sortie Std Dev	Percentage Sorties Flown	Average NMCS Rate	NMCS Std Dev
522/AS/O/B	4484	3881.27	338.91	86.56	11.19	9.55
522/AU/O/B	4484	4085	273	91.10	13.47	8.56
522/AS/N/B	4484	1935.2	415.61	43.16	56.02	8.88
522/AU/N/B	4484	1844.01	426.54	41.12	59.16	8.99
522/AS/O/U	4484	4225.97	29.92	94.25	0	0
522/AU/O/U	4484	4409.95	17.71	98.35	0.056	0.41
522/AS/N/U	4484	3882.27	316.69	86.58	11.49	7.39
522/AU/N/U	4484	3935.19	338.62	87.76	12.13	7.80

523rd Results

Table 4 displays the results of the 523rd, however, please refer to the previous discussion of the 522nd's results in view of the fact that they are the similar.

Table 4. 523rd LCOM Results

Squadron & Scenario	Sorties Scheduled	Avg Sorties Flown	Sortie Std Dev	Percentage Sorties Flown	Average NMCS Rate	NMCS Std Dev
523/AS/O/B	4074	3715.17	285.26	91.19	10.25	9.07
523/AU/O/B	4074	3858.05	228.25	94.70	12.91	9.25
523/AS/N/B	4074	1682.55	411.37	41.30	60.10	9.06
523/AU/N/B	4074	1720.97	365.99	42.24	59.91	8.07
523/AS/O/U	4074	3971.51	20.50	97.48	0	0
523/AU/O/U	4074	4062.45	6.02	99.72	0	0
523/AS/N/U	4074	3683.21	247.15	90.41	10.46	6.66
523/AU/N/U	4074	3662.87	340.18	89.91	12.09	8.76

524th Results

Table 5 displays the results of the 524th. Similar to the first two models, an apparent increase exists in the number of sorties produced as manpower is raised from assigned to authorized and all else is left at baseline levels. The difference lies in the second two scenarios where shifts are reduced to eight hours and no weekends and all else is modeled the same. Note that there is virtually no difference between sortie output between the first scenario where manpower is modeled as assigned (with overtime) and the third scenario where manpower is modeled as assigned (with no overtime). Also note that the NMCS rate of the third scenario is twice that of the NMCS rate from the first scenario without a corresponding decrease in sortie output. The scenario's where authorized manpower was modeled behaved similarly to the 522nd and 523rd models, although, there was less of an increase in the NMCS rates. The last four scenarios where parts were increased, however, behaved in the same manner as the 522nd and the 523rd.

These apparent differences between the models are troubling and will be readdressed later in this chapter.

Table 5. 524th LCOM Results

Squadron & Scenario	Sorties Scheduled	Avg Sorties Flown	Sortie Std Dev	Percentage Sorties Flown	Average NMCS Rate	NMCS Std Dev
524/AS/O/B	5672	4542.97	140.76	80.09	10.55	2.82
524/AU/O/B	5672	5097.19	208.37	89.87	13.72	4.29
524/AS/N/B	5672	4533.24	283.88	79.92	21.08	5.86
524/AU/N/B	5672	4594.96	313.22	81.01	21.45	5.87
524/AS/O/U	5672	4907.65	209.84	86.52	2.41	4.49
524/AU/O/U	5672	5359.33	223.57	94.49	4.19	6.08
524/AS/N/U	5672	4796.91	322.73	84.57	13.60	7.32
524/AU/N/U	5672	4857.73	345.29	85.64	14.07	7.38

Validity of the LCOM

A basic discussion of simulation model validation is required before the specifics of validating the baseline models are discussed. According to Law and Kelton there are three steps to validate a simulation model. The first step involves developing a model with high face validity. The second step involves testing the assumptions of the model empirically. The third step involves a common sense approach to determine if the output results resemble the system under study (Law and Kelton, 1992).

Developing a model with face validity means that the model, "on the surface, seems reasonable to people who are knowledgeable about the system under study." (Law and Kelton, 1992). The researcher spent some time reviewing the task networks (Form 30's) in the models provided to see if they were reasonable with respect to task times, resources, and equipment. The size and detail of the models prohibited a thorough analysis. The LCOM analysts who developed the respective studies used for this research routinely conduct field audits to verify that the information is accurate (Stone,

2002). Since the models used for this research were provided by ACC and, in fact, used to conduct actual manpower studies the researcher assumed that the models had face validity.

According to Law and Kelton the second step in validating a model involves testing the assumptions of the model empirically (1992). Again the models provided are assumed to have undergone this analysis during their development.

"The most definitive test of a simulation model's validity is establishing that its output data closely resemble the output data that would be expected from the actual (proposed) system." (Law and Kelton, 1992). Again, it is assumed that the models provided passed this test during manpower studies, however, since the models were modified as part of this research the focus of this research, is to perform this type of validity testing on the modified models.

Validation of Baseline Models

It is important to this research effort that the baseline models reflect the reality that they were modeled to portray. In the case of this research effort, one baseline model was built to reflect the manpower, shift schedules and parts availability for each flying unit studied at Cannon (522^{nd}, 523^{rd}, 524^{th}). The main dependent variable of concern was the number of sorties actually flown during FY2002 at Cannon by each flying unit. For the LCOM to be considered a viable tool for predicting maintenance capability it was important for each model to produce results that mirrored Cannon's FY2002 reality. In order to determine whether LCOM produced valid results, a z test was performed to test the following hypothesis for each respective flying unit.

522nd:

H_o: $\mu = \mu_0$ (3922 sorties that the 522nd actually flew during FY2002)

H_A: $\mu \neq \mu_0$ (3922 sorties)

523rd:

H_o: $\mu = \mu_0$ (3778 sorties that the 523rd actually flew during FY2002)

H_A: $\mu \neq \mu_0$ (3778 sorties)

524th:

H_o: $\mu = \mu_0$ (5179 sorties that the 524th actually flew during FY2002)

H_A: $\mu \neq \mu_0$ (5179 sorties)

where:

μ = Population mean of the number of sorties produced by the baseline model.

A z test is reserved for populations that are normally distributed. Since there were 75 data points, the Central Limit Theorem was invoked with the assumption that the distribution was approximately normal (Devore, 2000). Under this assumption the following formula taken from the Devore text could be used to determine the test statistic for each flying unit's results.

$$Z = \frac{\overline{X} - \mu_o}{\frac{S}{\sqrt{n}}}$$

where:

$\overline{X}$ = population mean of sorties produced by squadron (LCOM)
μ_o = Actual number of sorties produced (Actual FY2002)

S = Standard deviation of the population mean of sorties produced (LCOM)
n = 75 replications

The null hypothesis states that the LCOM sortie mean is the same as Cannon's actual FY2002 sorties. By using a two-tailed test with an $\alpha = .05$ level of significance the rejection region for the null hypothesis is established by the following inequalities: $z \leq -1.96$ or $z \geq 1.96$. In other words, if the absolute value of the z statistic exceeds 1.96 then it would be reasonable to assume that the LCOM simulation scenario was not capturing the reality of Cannon's flying hour program. Table 6 lists the results of this analysis.

Table 6. LCOM Baseline Model vs. Cannon's Actual Sortie Count

Squadron	FY2002 Sorties	LCOM Sortie μ	%	LCOM σ	Reps	Z Score	Reject Null?
522	3922	3881.27	98.96	338.91	75	-1.0408	No
523	3778	3715.17	98.34	285.26	75	-1.9076	No
524	5179	4542.97	87.72	140.76	75	-39.13	Yes

After analyzing the results from the z test presented in Table 6 above, the researcher concluded that there is insufficient evidence to reject the null hypothesis (the number of sorties produced by LCOM are equivalent to FY2002) for the 522nd and the 523rd. Also note that the 522nd and the 523rd simulation scenarios produced 98.96 and 98.34 percent, respectively, of the sorties that actually occurred during FY2002.

On the other hand there is sufficient evidence to suggest that the baseline model for the 524th does not produce the same number of sorties as reality. Since the 524th model failed to produce favorable results and the fact that there were troubling results as previously discussed in the results section, the 524th's model is suspect and will not be subject to further analysis.

As explained previously, trial and error through repeated adjustment of available parts was used to determine the NMCS rate of each squadron's baseline model. This trial and error process was conducted using only one replication of each model to save time so the possibility existed that after 75 replications this number could be different than anticipated. Table 7 presents the results after conducting a z test as described above but replaces the sortie statistics with NMCS statistics from each squadron.

Table 7. LCOM Baseline Model vs. Cannon's Actual NMCS Rate

Squadron	FY2002 NMCS	LCOM NMCS μ	LCOM σ	Reps	Z Score	Reject Null?
522	11.9	11.1871	9.547	75	-0.647	No
523	10.4	10.2545	9.067	75	-0.1385	No
524	10.2	10.5589	2.821	75	1.105	No

After analyzing the results from the z test presented in Table 7 above, the researcher concluded that there is sufficient evidence to suggest that the null hypothesis (the NMCS rates are equivalent) cannot be rejected for any of the squadrons.

Multifactor ANOVA

The second phase of the analysis involved conducting a multifactor ANOVA on the three different factors (manning, shifts, and parts availability) to determine whether or not they affect the response variable (sorties) (Devore, 2000). Since the 522nd and the 523rd passed the baseline validation the following tables (Tables 8 and 9) present the results of the analysis followed by a discussion of the results.

Table 8. 522nd Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	6	552042268	92007045	965.3625
Error	593	56517812	95308.284	Prob > F
C. Total	599	608560080		<.0001

The conclusions regarding this test for the 522nd are based on a whole model F test. To form a whole model F test, the JMP software divides the Mean Square for the Model by the Mean Square for Error. In this case, this quotient yields: 92,007,045 ÷ 95,308.284 = 965.363 as the F-ratio. Using 6 degrees of freedom (DF) in the numerator and 593 DF in the denominator, the critical value (taken from the F distribution table in the Devore text) is F~ 2.12 at a 0.05 level of significance. Since 965.363 ≥ 2.12 we can say that at least one of the factors (manpower, shifts, or parts availability) has a significant effect of the number of sorties produced for the 522nd simulation scenarios (Devore, 2000).

Table 9. 523rd Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	6	517786096	86297683	1126.45
Error	593	45429904	76610.294	Prob > F
C. Total	599	563216000		0.0000

Similarly for the 523rd, the quotient yields: 86,297,683 ÷ 76,610.294 = 1126.45 as the F-ratio. Using 6 degrees of freedom (DF) in the numerator and 593 DF in the denominator, the critical value (taken from the F distribution table in the Devore text) is F~ 2.12 at a 0.05 level of significance. Since 1126.45 ≥ 2.12 we can say that at least one of the factors (manpower, shifts, or parts availability) has a significant effect of the number of sorties produced for the 523rd simulation scenarios (Devore, 2000).

Comparison of Each Simulation Scenario

This phase of the analysis focused on LCOM's ability to react to variations in manpower, shift scheduling and part availability. Since the baseline model for the 524th did not produce favorable results when measuring its ability to replicate reality, the results from successive tests for that model will not be analyzed. The results and analysis of the remaining two squadrons, which incidentally were modeled with the modified block 30 databases, will be discussed in the following paragraphs. To avoid confounding the results by the introduction of increased randomness, the researcher ran comparative analysis on models where only one factor was manipulated while the remaining two factors were held constant between pairwise comparisons.

The analysis and results for this phase of the research focused on comparing the sortie means of each of the models where factors were varied. There are six different tables (three for the 522nd and three for the 523rd) used in the following text to display the results of 24 hypothesis tests used to compare the sortie means of the models. The Central Limit Theorem was invoked and the synchronization of the model random number streams enabled the used of a paired t-test to determine if a difference existed between the means of each model studied (Devore, 2000). The following hypotheses were used for each of the 24 tests.

H_o: $\mu_d = 0$ (The is no difference between the sortie count means)

H_a: $\mu_d \neq 0$ (There is a difference between the sortie count means)

The test statistic used to calculate the t value was:

$$t = \frac{\bar{d} - \Delta_o}{\frac{s_d}{\sqrt{n}}}$$

where:

$\bar{d}$ = Sample mean of the differences in sortie count (LCOM)
Δ_o = Null hypothesis value (zero for all tests)
s_d = Sample standard deviation of the differences in sortie count (LCOM)
n = 75 replications

By using a two-tailed test with an $\alpha = .05$ level of significance the rejection region for the null hypothesis is established by the following inequalities: $t \leq -2.00$ or $t \geq 2.00$. In other words, if the absolute value of the t statistic exceeds 2.00 then it would be reasonable to assume that the differences between the baseline model and the comparison model are statistically significant.

Effect of Manpower Variation (522nd)

Table 10 shows the results of comparing the sortie means of simulation runs of the 522nd where manpower was varied between AU and AS, and shifts and parts availability were held constant between pairwise comparisons.

Table 10. 522nd Manpower Pairwise Comparison

Squadron & Scenario	Sample mean of Differences	Sample Std Dev of Differences	Number of Reps	t-score	Reject Null?
522/AS/O/B-522/AU/O/B	-203.573	409.85	75	-4.302	Y
522/AS/O/U-522/AU/O/U	-183.973	35.745	75	-44.573	Y
522/AS/N/B-522/AU/N/B	91.187	538.9	75	1.465	N
522/AS/N/U-522/AU/N/U	-52.92	448.95	75	-1.021	N

The results in the first two rows show that there is a statistically significant difference between the number of sorties produced when manpower levels are varied between authorized and assigned. Specifically, the number of sorties increases as manpower levels are raised from assigned to authorized. This increase reflects what should actually occur at a unit where manpower is a constraint.

The results in the last two rows show that we cannot reject the null hypothesis that the sortie means are the same. The difference between the scenarios in the first two rows and the scenarios in the last two rows lies in the shift philosophies modeled. The first two rows modeled "O" which means that they worked 10-hour shifts and weekends. The last two rows modeled "N" which means that they worked eight hours shifts and no weekends. The results of the last two rows are interesting as they suggest that reducing shift hours and eliminating weekend work minimizes the effect of an increase in manning.

Effect of Manpower Variation (523rd)

Table 11 shows the results of comparing the sortie means of simulation runs of the 523rd where manpower was varied between AU and AS, and shifts and parts availability were held constant between pairwise comparisons.

Table 11. 523rd Manpower Pairwise Comparison

Squadron & Scenario	Sample mean of Differences	Sample Std Dev of Differences	Number of Reps	t-score	Reject Null?
523/AS/O/B-523/AU/O/B	-142.88	375.566	75	-3.295	Y
523/AS/O/U-523/AU/O/U	-90.947	19.908	75	-39.563	Y
523/AS/N/B-523/AU/N/B	-38.427	483.851	75	-0.688	N
523/AS/N/U-523/AU/N/U	20.347	435.724	75	0.404	N

The results for the 523rd mirror the results for the 522nd discussed above.

Effect of Shift Variation (522nd)

Table 12 shows the results of comparing the sortie means of simulation runs of the 522nd where shifts were varied between O and N, and manpower and parts availability were held constant between pairwise comparisons.

Table 12. 522nd Shift Pairwise Comparison

Squadron & Scenario	Sample mean of Differences	Sample Std Dev of Differences	Number of Reps	t-score	Reject Null?
522/AS/O/B-522/AS/N/B	1946.067	498.045	75	33.839	Y
522/AU/O/B-522/AU/N/B	2240.827	455.912	75	42.566	Y
522/AS/O/U-522/AS/N/U	343.707	315.333	75	9.44	Y
522/AU/O/U-522/AU/N/U	474.76	337.183	75	12.194	Y

The results of the hypothesis testing show, in all cases, that there is a significant difference between the number of sorties produced when shifts are varied from O (10-hours and weekends) to N (8-hours and no weekends). These results reflect what we should expect to see when the number of available man-hours is reduced.

Effect of Shift Variation (523rd)

Table 13 shows the results of comparing the sortie means of simulation runs of the 523rd where shifts were varied between O and N, and manpower and parts availability were held constant between pairwise comparisons.

Table 13. 523rd Shift Pairwise Comparison

Squadron & Scenario	Sample mean of Differences	Sample Std Dev of Differences	Number of Reps	t-score	Reject Null?
523/AS/O/B-523/AS/N/B	2032.627	491.6	75	35.808	Y
523/AU/O/B-523/AU/N/B	2137.08	426.099	75	43.435	Y
523/AS/O/U-523/AS/N/U	288.293	244.921	75	10.194	Y
523/AU/O/U-523/AU/N/U	399.587	339.453	75	10.194	Y

The results for the 523rd mirror the results for the 522nd discussed above.

Effect of Parts Availability Variation (522nd)

Table 14 shows the results of comparing the sortie means of simulation runs of the 522nd where parts were varied between B and U, and manpower and shifts were held constant between pairwise comparisons.

Table 14. 522nd NMCS Pairwise Comparison

Squadron & Scenario	Sample mean of Differences	Sample Std Dev of Differences	Number of Reps	t-score	Reject Null?
522/AS/O/B-522/AS/O/U	-344.707	336.8	75	-8.864	Y
522/AU/O/B-522/AU/O/U	-325.107	275.517	75	-10.219	Y
522/AS/N/B-522/AS/N/U	-1947.067	472.467	75	-35.689	Y
522/AU/N/B-522/AU/N/U	-2091.173	465.679	75	-38.89	Y

The results of the hypothesis testing show, in all cases, that there is a significant difference between the number of sorties produced when parts available are varied from B (NMCS rate determine by the baseline) to U (virtually unlimited as determined by the most constraining scenario). These results reflect what we should expect to see when the number of available man-hours is reduced.

Effect of Parts Availability Variation (523rd)

Table 15 shows the results of comparing the sortie means of simulation runs of the 523rd where parts were varied between B and U, and manpower and shifts were held constant between pairwise comparisons.

Table 15. 523 NMCS Pairwise Comparison

Squadron & Scenario	Sample mean of Differences	Sample Std Dev of Differences	Number of Reps	t-score	Reject Null?
523/AS/O/B-523/AS/O/U	-256.333	288.864	75	-7.685	Y
523/AU/O/B-523/AU/O/U	-204.4	228.368	75	-7.751	Y
523/AS/N/B-523/AS/N/U	-2000.667	436.898	75	-39.658	Y
523/AU/N/B-523/AU/N/U	-1941.893	516.451	75	-32.563	Y

The results for the 523rd mirror the results for the 522nd discussed above.

Summary of Factor Variation Effects

The following paragraph summarizes the effect on the LCOM's sortie output as analyzed during the pairwise comparisons (Tables 10 through 15) where manpower, shifts, or parts were varied. In general, when manpower levels were raised from assigned to authorized there were marginal gains in the numbers of sorties produced (~ 190 sortie increase). When shifts were reduced from overtime to normal shifts there was a

significant decrease in the number of sorties produced (loss of ~2000 sorties). Finally when the number of parts was increased from baseline levels there was a significant increase in the number of sorties produced (~ 2000 sorties).

Investigative Questions Answered

The purpose of this research effort is contained within the overarching research question: "Can the LCOM be modified by using the actual peacetime maintenance manpower numbers, shift schedules, and parts availability numbers from an active duty squadron to assess that squadron's current maintenance capacity to execute flying schedules?" To answer this question several investigative questions had to be answered first. The following paragraphs restate the investigative questions and provide the researcher's answers to those questions base on the analysis previously discussed.

Given previous year data from an F-16 wing (manpower level, flying schedule, and supply rates) will LCOM produce the same sortie rates that the wing actually attained?

The answer to this question is based on the results of the baseline model analysis. Two of the three baseline models that simulated the 522nd, 523rd, and 524th's actual FY2002 parameters provided sufficient evidence to suggest that the sorties rates from the LCOM are same as the actual sortie rate. The two baseline models that met the comparison were the 522nd and the 523rd, which were built using the Block 30 model provided by ACC. The third baseline model, which simulated the 524th, provided sufficient evidence to suggest that the simulated sortie rate and the actual sortie rate were

different. For this reason, answers to the following investigative questions will only consider the 522nd and the 523rd.

Is the LCOM sensitive enough to produce differences in the number of sorties as manning levels are varied between authorized and assigned?

The answer to this question is mixed. The first two rows in Tables 10 and 11 show the results of scenarios for the 522nd and the 523rd, respectively, where shifts and parts availability simulated Cannon's FY2002 numbers. The results for both squadrons suggest that there is a difference between sortie outputs when manpower is increased from assigned to authorized. These results pass Law and Kelton's third validity test, which is designed to compare the simulation output with reality (Law and Kelton, 1992). In other words, we should expect to see the increase in the number of sorties produced with an increase in manpower.

The last two rows in the tables show the results from scenarios where shifts were reduced to match command guidance (8 hours and no weekends). Parts availability, in this case, were held at Cannon's FY2002 numbers. These results suggest that we cannot reject the null hypothesis, which states that the two sortie outputs are equal. These results cause problems when relating them to Law and Kelton's third validity test since we should expect to see an increase in the number of sorties produced with an increase in manpower. An explanation for the absence of a sortie increase might be explained by the possibility that shift variances have a larger impact on sortie production than do manpower increases from assigned to authorized.

Is the LCOM sensitive enough to produce differences in the number of sorties as shift-scheduling philosophies are varied between 10-hour shifts/weekend work and 8-hour shifts/no weekend work?

Tables 12 and 13 show the results of scenarios for the 522nd and the 523rd, respectively, where manpower and parts availability were held constant between each pairwise comparison while the different shift scenarios were compared against one another. The results for both squadrons suggest that there is a significant difference between sortie outputs when shifts are varied between overtime and normal hours. In every case a reduction in shift hours resulted in a corresponding decrease in the number of sorties produced. These results pass Law and Kelton's third validity test, which is designed to compare the simulation output with reality (Law and Kelton, 1992). In other words, we should expect to see a decrease in the number of sorties produced with a decrease in the number of available man-hours. A concern, however, exists in the differing NMCS rate results realized between the Block 30 and Block 40 models. These concerns will be addressed in Chapter 5.

Is the LCOM sensitive enough to produce differences in the number of sorties as parts availability is varied?

Tables 14 and 15 show the results of scenarios for the 522nd and the 523rd, respectively, where manpower and shifts were held constant between each pairwise comparison while the different parts scenarios were compared against one another. The results for both squadrons suggest that there is a significant difference between sortie outputs when parts are varied between baseline levels and more parts. In every case an

increase in parts resulted in a corresponding increase in the number of sorties produced. These results pass Law and Kelton's third validity test, which is designed to compare the simulation output with reality (Law and Kelton, 1992). In other words, we should expect to see an increase in the number of sorties produced with an increase in the number of available parts.

What factors (manpower, shift scheduling, or parts availability) are most influential to the LCOM in terms of sortie production?

Tables 16 and 17 for the 522nd and the 523rd, respectively, show the F-Ratios from the multifactor ANOVA test performed earlier. A comparison of each factor's F-Ratio to the F critical value of 2.12 (determined in prior analysis) suggests that all of the factors have significant influence on the number of sorties produced except for the crossed term of manning * parts. A rank order of the basic terms in the analysis reveals that shifts have the most influence followed by parts and then manning.

Table 16. 522nd Factor Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Manning	1	1	1143717	12.0002	0.0006
Shifts	1	1	234877769	2464.4	<.0001
Manning*Shifts	1	1	1699847	17.8352	<.0001
Parts	1	1	207804058	2180.336	<.0001
Manning*Parts	1	1	145330	1.5248	0.2174
Shifts*Parts	1	1	106371546	1116.079	<.0001

Table 17. 523rd Factor Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Manning	1	1	594909	7.7654	0.0055
Shifts	1	1	221213890	2887.522	<.0001
Manning*Shifts	1	1	436375	5.6960	0.0173
Parts	1	1	181771802	2372.681	<.0001
Manning*Parts	1	1	114900	1.4998	0.2212
Shifts*Parts	1	1	113654221	1483.537	<.0001

Summary

The purpose of this chapter was to report the results and analysis of the simulation scenarios conducted according to the methodology discussed in the previous chapter. The results and analysis presented in this chapter were broken down into four areas designed to answer the investigative questions presented in Chapter 1. The chapter concluded with a restatement of the investigative questions followed by conclusions to those questions in light of the analysis.

V. Conclusions and Recommendations

Chapter Overview

The purpose of this chapter is to discuss the conclusions and recommendations of this research effort. The chapter will begin with a discussion of the conclusions to the overarching research question followed by a discussion of the significance of those conclusions. The chapter will then move to a discussion of the recommendations for action based on these conclusions. The chapter will conclude with recommendations for future research.

Conclusions of Research

The purpose of this research effort was guided by the pursuit of an answer to the overarching research question "Can the LCOM be modified by using the actual peacetime maintenance manpower numbers, shift schedules, and parts availability numbers from an active duty squadron to assess that squadron's current maintenance capacity to execute flying schedules?" The conclusions to the investigative questions derived from the research question were addressed at the end of Chapter 4. The following paragraphs focus on the conclusions to the research question.

The simulation scenarios used to conduct this research provided mixed results. The squadrons simulated with the Block 30 model (522nd and the 523rd) provided favorable results. In other words, these models when modified to reflect the actual manpower numbers, shifts, and NMCS rate, produced the same numbers through simulation that each squadron realized during FY2002. Which indicates that the Block

30 model (provided by ACC), under these conditions, would be a useful tool in estimate maintenance manpower capacity for a Block 30 F-16 squadron.

The Block 40 model which was modified to simulate the 524th, failed to provide sortie numbers that mirrored FY2002. In fairness to the Block 40 model and the analysts who built it, the reason for this may be due to a lack of understanding of the total model on the researcher's part. Another reason could be attributed the possibility that the 524th, which is the unit that the Block 40 model was built to simulate, performed a "Herculean" feat by executing a schedule that the LCOM indicates was too much. A final reason could be the relative instability of the model, which was characterized by peculiar results as presented in Table 5.

The main area of concern when discussing the differences between the Block 30 and Block 40 model lies in the NMCS rate difference realized between the results of scenarios where shift policy was reduced from 10-hour shifts and weekend work to 8-hour shifts and no weekend work. When the Block 40 model was modified to the reduced shift policy while leaving parts availability at baseline levels the NMCS rate for either authorized or assigned manpower averaged approximately 21%. The NMCS rates for the Block 30 model under the same conditions, on the other hand, ranged from 56 to 60 %. The difference between these two outcomes causes this researcher some concern in light of the fact that the backshop manpower modeled under all scenarios was exactly the same. Recommendations for action, which address these concerns, will be discussed later in this chapter.

Significance of Research

A tool that could be used in the field to estimate the current capacity of an aircraft maintenance unit to produce sorties may prove to be extremely useful for a number of reasons. First, maintainers currently compensate for the lack of accurate annual flying hour planning by working weekends and long hours, which contributes to the AF's retention problems. Second, by planning more accurately, maintainers would work fewer hours and avoid weekend work, which would alleviate this negative retention component. The LCOM is a tool that the researcher believes would fit this need.

Recommendations for Action

Recommendations for action revolve around the differing sortie production and NMCS rate results found while using two different software models (Block 30 and 40). One of the differences between the Block 30 and Block 40 models that could lead to differing sortie and NMCS rate results is the methodology used to model scheduled maintenance tasks such as phase inspections. The Block 30 model uses attributes to track and schedule these inspections where as the Block 40 model relies heavily on the analyst to schedule these events.

Another difference between the two models is the manner in which task networks were developed in the Block 30 or Block 40 models. This researcher believes that the task networks between nearly identical aircraft (Block 30 and Block 40 F-16's) should be of a similar nature. The 40 Percentage point swing in the results of NMCS rates between these two models suggests that the task networks are substantially different. As discussed

before, this researcher believes that a shift reduction policy should have impacted each model in a similar manner.

While the researcher does not claim to be an expert on the LCOM it seems logical that standard procedures for developing models for manpower studies should be developed. These procedures should, at a minimum, standardize the methods and procedures used in modeling scheduled maintenance tasks by either scheduling them manually or utilizing attributes. In addition, the methodology and assumptions used to build task networks should be the same. Standardization of these processes for LCOM manpower studies would eliminate differences induced by individual analyst's modeling practices resulting in more reliable analysis.

Recommendations for Future Research

Several opportunities for future research into the LCOM maintenance capability phenomenon exist. The short list below represents the topics most interesting to the researcher.

1. Conduct an LCOM study to determine the affect of skill level mixture (3-, 5-, and 7-level) on maintenance capability. Skill level productivity factors would need to be developed as discussed in Chapter 2 to transform actual manning numbers from a unit into aggregate numbers that the LCOM can employ.

2. Conduct an LCOM study to determine the affect that specific AFSC's have on the simulated sortie count and NMCS rates. Seek to identify which AFSC's are constraining LCOM's ability to produce sorties when actual manpower numbers from a

unit are used. Verify that the constraining AFSC is the same as what the unit actually believes is constraining.

3. Conduct an LCOM study to determine if the wartime scenarios used to conduct manpower studies represent the most demanding schedule maintainers face. Since peacetime schedules are generally built around 8, 10, or 12 fronts, determine if this presents a greater demand for the maintenance workforce.

4. Conduct an LCOM study to determine the affect that split operations has on maintenance capacity. This would entail converging on manpower, aircraft and, equipment numbers that accurately depict split operations.

5. Conduct an LCOM study to determine the affect of tail number scheduling on sortie output. This would entail learning how to model tail number scheduling in the LCOM.

6. Conduct an LCOM study to assess LCOM's usefulness in the field. This would entail travel to an operational unit to educate potential users on the LCOM model and then assessing their perceptions on the ease of use and accuracy of the model.

7. Conduct a study to explore the various techniques used by LCOM analysts used to build aircraft models. Determine if a set of "best practices" can be developed to standardize the process.

Summary

The purpose of this chapter was to discuss the conclusions and recommendations of this research effort. The chapter began with a discussion of the conclusions to the

overarching research question followed by a discussion of the significance of those conclusions. The chapter then moved to a discussion of the recommendations for action based on these conclusions. The chapter concluded with recommendations for future research.

Appendix A. Manpower Conversion Worksheets

WING TOTAL									
AFSC	**NAME**	**Auth**	**Assign**	**% of Auth**	**LCOM norm Auth**	**LCOM norm Assign**	1.461 **522%**	**523%**	**524%**
2A332	Avionics	31	29	93.55%	21.22	19.85	26.00%	29.00%	45.00%
2A352	Avionics	85	48	56.47%	58.18	32.85	25.00%	25.00%	50.00%
2A372	Avionics	21	11	52.38%	14.37	7.53	24.00%	24.00%	52.00%
	Total	**137**	**88**	**64.23%**	**93.77**	**60.23**	**25.00%**	**25.00%**	
2A333	Crew Chief	77	146	189.61%	52.70	99.93	29.00%	34.00%	38.00%
2A353	Crew Chief	169	92	54.44%	115.67	62.97	33.00%	30.00%	37.00%
2A373	Crew Chief	42	30	71.43%	28.75	20.53	31.00%	31.00%	38.00%
	Total	**288**	**268**	**93.06%**	**197.13**	**183.44**	**31.00%**	**31.00%**	**38.00%**
2A333	F/L Crew Chief	60	114				77.00%	81.00%	76.00%
2A353	F/L Crew Chief	123	67				75.00%	73.00%	71.00%
2A373	F/L Crew Chief	27	19				62.00%	62.00%	69.00%
	Total	**210**	**200**						
2A333	Phs Crew Chief	17	32				23.00%	19.00%	24.00%
2A353	Phs Crew Chief	46	25				25.00%	27.00%	29.00%
2A373	Phs Crew Chief	15	11				38.00%	38.00%	31.00%
	Total	**78**	**68**						
2A631	Engines	13	13	100.00%	8.90	8.90	31.00%	31.00%	38.00%
2A651	Engines	33	18	54.55%	22.59	12.32	33.00%	30.00%	36.00%
2A671	Engines	6	5	83.33%	4.11	3.42	17.00%	33.00%	50.00%
	Total	**52**	**36**	**69.23%**	**35.59**	**24.64**			
2A636	Elec/Env	6	18	300.00%	4.11	12.32	33.00%	33.00%	34.00%
2A656	Elec/Env	21	12	57.14%	14.37	8.21	33.00%	33.00%	34.00%
2A676	Elec/Env	6	4	66.67%	4.11	2.74	33.00%	33.00%	34.00%
	Total	**33**	**34**	**103.03%**	**22.59**	**23.27**			
2W131	Weapons	53	70	132.08%	36.28	47.91	33.00%	33.00%	34.00%
2W151	Weapons	128	67	52.34%	87.61	45.86	33.00%	33.00%	34.00%
2W171	Weapons	44	28	63.64%	30.12	19.16	33.00%	33.00%	34.00%
	Total	**225**	**165**	**73.33%**	**154.00**	**112.94**			

522							
AFSC	**NAME**	**Auth**	**Assign**	**% of Auth**	**LCOM norm Auth**	**LCOM norm Assign**	**1.461**
2A332	Avionics	8.00	7.54	94.25%	5.48	5.16	
2A352	Avionics	21.00	12.00	57.14%	14.37	8.21	
2A372	Avionics	5.00	2.64	52.80%	3.42	1.81	
	Total	**34.00**	**22.00**	**64.71%**	**23.27**	**15.06**	
2A333	Crew Chief	22.00	42.34	192.45%	15.06	28.98	
2A353	Crew Chief	55.00	30.36	55.20%	37.65	20.78	
2A373	Crew Chief	13.00	9.30	71.54%	8.90	6.37	
	Total	**90.00**	**82.00**	**91.11%**	**61.60**	**56.13**	
2A333	F/L Crew Chief	17.00	32.60	191.78%	11.64	22.31	
2A353	F/L Crew Chief	41.00	22.77	55.54%	28.06	15.59	
2A373	F/L Crew Chief	8.00	5.77	72.08%	5.48	3.95	
	Total	**66.00**	**61.14**	**92.63%**	**45.17**	**41.85**	
2A333	Phs Crew Chief	5.00	9.74	194.76%	3.42	6.67	
2A353	Phs Crew Chief	14.00	7.59	54.21%	9.58	5.20	
2A373	Phs Crew Chief	5.00	3.53	70.68%	3.42	2.42	
	Total	**24.00**	**20.86**	**86.93%**	**16.43**	**14.28**	
2A631	Engines	4.00	4.03	100.75%	2.74	2.76	
2A651	Engines	11.00	5.94	54.00%	7.53	4.07	
2A671	Engines	1.00	0.85	85.00%	0.68	0.58	
	Total	**16.00**	**10.82**	**67.63%**	**10.95**	**7.41**	
2A636	Elec/Env	2.00	5.94	297.00%	1.37	4.07	
2A656	Elec/Env	7.00	3.96	56.57%	4.79	2.71	
2A676	Elec/Env	2.00	1.32	66.00%	1.37	0.90	
	Total	**11.00**	**11.22**	**102.00%**	**7.53**	**7.68**	
2W131	Weapons	17.00	23.10	135.88%	11.64	15.81	
2W151	Weapons	43.00	22.11	51.42%	29.43	15.13	
2W171	Weapons	15.00	9.24	61.60%	10.27	6.32	
	Total	**75.00**	**54.45**	**72.60%**	**51.33**	**37.27**	
2W131	Weapons MX	4.00	5.31	132.83%	2.74	3.64	
2W151	Weapons MX	8.00	5.09	63.57%	5.48	3.48	
2W171	Weapons MX	5.00	2.13	42.50%	3.42	1.45	
	Total	**17.00**	**12.52**	**73.67%**	**11.64**	**8.57**	
2W131	Weapons Load	13.00	17.79	136.82%	8.90	12.17	
2W151	Weapons Load	35.00	17.02	48.64%	23.96	11.65	
2W171	Weapons Load	10.00	7.11	71.15%	6.84	4.87	
	Total	**58.00**	**41.93**	**72.29%**	**39.70**	**28.70**	

523							
AFSC	**NAME**	**Auth**	**Assign**	**% of Auth**	**LCOM norm Auth**	**LCOM norm Assign**	**1.461**
2A332	Avionics	9.00	8.41	93.44%	6.16	5.76	
2A352	Avionics	21.00	12.00	57.14%	14.37	8.21	
2A372	Avionics	5.00	2.64	52.80%	3.42	1.81	
	Total	**35.00**	**23.05**	**65.86%**	**23.96**	**15.78**	
2A333	Crew Chief	26.00	49.64	190.92%	17.80	33.98	
2A353	Crew Chief	51.00	27.60	54.12%	34.91	18.89	
2A373	Crew Chief	13.00	9.30	71.54%	8.90	6.37	
	Total	**90.00**	**86.54**	**96.16%**	**61.60**	**59.23**	
2A333	F/L Crew Chief	21.00	40.21	191.47%	14.37	27.52	
2A353	F/L Crew Chief	37.00	20.15	54.45%	25.33	13.79	
2A373	F/L Crew Chief	8.00	5.77	72.08%	5.48	3.95	
	Total	**66.00**	**66.12**	**100.19%**	**45.17**	**45.26**	
2A333	Phs Crew Chief	5.00	9.43	188.63%	3.42	6.46	
2A353	Phs Crew Chief	14.00	7.45	53.23%	9.58	5.10	
2A373	Phs Crew Chief	5.00	3.53	70.68%	3.42	2.42	
	Total	**24.00**	**20.42**	**85.07%**	**16.43**	**13.98**	
2A631	Engines	4.00	4.03	100.75%	2.74	2.76	
2A651	Engines	10.00	5.40	54.00%	6.84	3.70	
2A671	Engines	2.00	1.65	82.50%	1.37	1.13	
	Total	**16.00**	**11.08**	**69.25%**	**10.95**	**7.58**	
2A636	Elec/Env	2.00	5.94	297.00%	1.37	4.07	
2A656	Elec/Env	7.00	3.96	56.57%	4.79	2.71	
2A676	Elec/Env	2.00	1.32	66.00%	1.37	0.90	
	Total	**11.00**	**11.22**	**102.00%**	**7.53**	**7.68**	
2W131	Weapons	19.00	23.10	121.58%	13.00	15.81	
2W151	Weapons	42.00	22.11	52.64%	28.75	15.13	
2W171	Weapons	14.00	9.24	66.00%	9.58	6.32	
	Total	**75.00**	**54.45**	**72.60%**	**51.33**	**37.27**	
2W131	Weapons MX	4.00	5.31	132.83%	2.74	3.64	
2W151	Weapons MX	8.00	5.09	63.57%	5.48	3.48	
2W171	Weapons MX	5.00	2.13	42.50%	3.42	1.45	
	Total	**17.00**	**12.52**	**73.67%**	**11.64**	**8.57**	
2W131	Weapons Load	13.00	17.79	136.82%	8.90	12.17	
2W151	Weapons Load	35.00	17.02	48.64%	23.96	11.65	
2W171	Weapons Load	10.00	7.11	71.15%	6.84	4.87	
	Total	**58.00**	**41.93**	**72.29%**	**39.70**	**28.70**	

524							
AFSC	**NAME**	**Auth**	**Assign**	**% of Auth**	**LCOM norm Auth**	**LCOM norm Assign**	**1.461**
2A332	Avionics	14.00	13.05	93.21%	9.58	8.93	
2A352	Avionics	43.00	24.00	55.81%	29.43	16.43	
2A372	Avionics	11.00	5.72	52.00%	7.53	3.92	
	Total	**68.00**	**42.77**	**62.90%**	**46.54**	**29.27**	
2A333	Crew Chief	29.00	55.48	191.31%	19.85	37.97	
2A353	Crew Chief	63.00	34.04	54.03%	43.12	23.30	
2A373	Crew Chief	16.00	11.40	71.25%	10.95	7.80	
	Total	**108.00**	**100.92**	**93.44%**	**73.92**	**69.08**	
2A333	F/L Crew Chief	22.00	42.16	191.66%	15.06	28.86	
2A353	F/L Crew Chief	45.00	24.17	53.71%	30.80	16.54	
2A373	F/L Crew Chief	11.00	7.87	71.51%	7.53	5.38	
	Total	**78.00**	**74.20**	**95.13%**	**53.39**	**50.79**	
2A333	Phs Crew Chief	7.00	13.32	190.22%	4.79	9.11	
2A353	Phs Crew Chief	18.00	9.87	54.84%	12.32	6.76	
2A373	Phs Crew Chief	5.00	3.53	70.68%	3.42	2.42	
	Total	**30.00**	**26.72**	**89.07%**	**20.53**	**18.29**	
2A631	Engines	5.00	4.94	98.80%	3.42	3.38	
2A651	Engines	12.00	6.48	54.00%	8.21	4.44	
2A671	Engines	3.00	2.50	83.33%	2.05	1.71	
	Total	**20.00**	**13.92**	**69.60%**	**13.69**	**9.53**	
2A636	Elec/Env	2.00	6.12	306.00%	1.37	4.19	
2A656	Elec/Env	7.00	4.08	58.29%	4.79	2.79	
2A676	Elec/Env	2.00	1.36	68.00%	1.37	0.93	
	Total	**11.00**	**11.56**	**105.09%**	**7.53**	**7.91**	
2W131	Weapons	17.00	23.80	140.00%	11.64	16.29	
2W151	Weapons	43.00	22.78	52.98%	29.43	15.59	
2W171	Weapons	15.00	9.52	63.47%	10.27	6.52	
	Total	**75.00**	**56.10**	**74.80%**	**51.33**	**38.40**	
2W131	Weapons MX	4.00	5.47	136.85%	2.74	3.75	
2W151	Weapons MX	8.00	5.24	65.49%	5.48	3.59	
2W171	Weapons MX	5.00	2.19	43.79%	3.42	1.50	
	Total	**17.00**	**12.90**	**75.90%**	**11.64**	**8.83**	
2W131	Weapons Load	13.00	18.33	140.97%	8.90	12.54	
2W151	Weapons Load	35.00	17.54	50.12%	23.96	12.01	
2W171	Weapons Load	10.00	7.33	73.30%	6.84	5.02	
	Total	**58.00**	**43.20**	**74.48%**	**39.70**	**29.57**	

COMPONENT REPAIR SQUADRON

AFSC	NAME	Auth	Assign	% assign	LCOM AUTH	LCOM ASSIGN	1.461			
2A636	Elec/Env	7	10.00	142.86%	4.79	6.84				
2A656	Elec/Env	19	9.00	47.37%	13.00	6.16				
2A676	Elec/Env	4	3.00	75.00%	2.74	2.05				
		30	22.00	73.33%	20.53	15.06				
2A634	Fuels	13	24.00	184.62%	8.90	16.43				
2A654	Fuels	35	17.00	48.57%	23.96	11.64				
2A674	Fuels	9	7.00	77.78%	6.16	4.79				
		57	48.00	84.21%	39.01	32.85				
2A633	Egress	11	21.00	190.91%	7.53	14.37				
2A653	Egress	22	12.00	54.55%	15.06	8.21				
2A673	Egress	5	5.00	100.00%	3.42	3.42				
		38	38.00	100.00%	26.01	26.01				
2A635	Hydraulics	2	2.00	100.00%	1.37	1.37				
2A655	Hydraulics	5	5.00	100.00%	3.42	3.42				
2A675	Hydraulics	2	3.00	150.00%	1.37	2.05				
		9	10.00	111.11%	6.16					
AFSC	**NAME**	**Access**	**Shop**	**Support**	**Test cell**	**Auth Total**	**Assign Total**	**%**	**LCOM AUTH**	**LCOM ASSIGN**
2A631	Engines	1	6	2.00	0	9	13.00	144.44%	6.16	8.90
2A651	Engines	2	9	6.00	12	29	21.00	72.41%	19.85	14.37
2A671	Engines	1	9	1.00	3	14	24.00	171.43%	9.58	16.43
		4	24	9.00	15	52	58.00	111.54%	35.59	39.70
					LCOM	LCOM	1.461			
					AUTH	ASSIGN				
2A137	E/W	6	5.00	83.33%	4.11	3.42				
2A157	E/W	20	16.00	80.00%	13.69	10.95				
2A177	E/W	6	5.00	83.33%	4.11	3.42				
		32	26.00	81.25%	21.90	17.80				
2A131	Sensors	4	3.00	75.00%	2.74	2.05				
2A151	Sensors	10	8.00	80.00%	6.84	5.48				
2A171	Sensors	4	3.00	75.00%	2.74	2.05				
		18	14.00	77.78%	12.32	9.58				
2A031	Test Station	6	5.00	83.33%	4.11	3.42				
2A051	Test Station	17	13.00	76.47%	11.64	8.90				
2A071	Test Station	6	5.00	83.33%	4.11	3.42				
		29	23.00	79.31%	19.85	15.74				

EQUIPMENT MAINTENANCE SQUADRON											
AFSC	**NAME**	**Auth**	**Assign**	**% assign**	**LCOM AUTH**	**LCOM ASSIGN**	**1.461**				
2A734	Survival	3	2.00	66.67%	2.05	1.37					
2A754	Survival	3	4.00	133.33%	2.05	2.74					
2A774	Survival	4	3.00	75.00%	2.74	2.05					
		10	9.00	90.00%	6.84	6.16					
2A731	Metals Tech	7	9.00	128.57%	4.79	6.16					
2A751	Metals Tech	15	7.00	46.67%	10.27	4.79					
2A771	Metals Tech	4	2.00	50.00%	2.74	1.37					
		26	18.00	69.23%	17.80	12.32					
2A732	NDI	3	5.00	166.67%	2.05	3.42					
2A752	NDI	15	7.00	46.67%	10.27	4.79					
2A772	NDI	3	1.00	33.33%	2.05	0.68					
		21	13.00	61.90%	14.37	8.90					
2A733	Structural Mx	15	20.00	133.33%	10.27	13.69					
2A753	Structural Mx	39	16.00	41.03%	26.69	10.95					
2A773	Structural Mx	12	11.00	91.67%	8.21	7.53					
		66	47.00	71.21%	45.17	32.17					
		LGMRA	**LGMRB**	**LGMRC**	**LGMRD**	**LGMRS**	**Total Auth**	**Assign**		**LCOM Auth**	**LCOM Assign**
2W131	Armament	4	4	4.00	0	1	13.00	16	123.08%	8.90	10.95
2W151	Armament	5	5	7.00	4	3	24.00	11	45.83%	16.43	7.53
2W171	Armament	3	2	2.00	1	1	9.00	5	55.56%	6.16	3.42
		12					46.00	32	69.57%	31.49	21.90
2A333	W&TIRE	4	3.00	75.00%	2.74	2.05					
2A353	W&TIRE	8	6.00	75.00%	5.48	4.11					
2A373	W&TIRE	3	2.00	66.67%	2.05	1.37					
		15	11.00	73.33%	10.27	7.53					
2W031	Munitions	41	35	85.37%	28.06	23.96					
2W051	Munitions	107	91	85.05%	73.24	62.29					
2W071	Munitions	148	126	85.14%	101.30	86.24					
		296.00	252	85.14%	202.60	172.48					

Appendix B. Changecard Example

```
PERIOD,30,360,WARMUP
LV1RPT,30,360,
,LV2RPT,N,Y
,LV3RPT
LV1_STATS,A5,C6
,LV1_STATS,G,H,
,LV2_STATS,A5,C6
,LV3RPT
,PSR_STATS,ALL,
,PSRRPT,N,Y,LEVEL3,
PSR_STATS,A5,C6
,PSR_STATS,G,H,
PSRRPT,N,Y,LEVEL2,
,MINMAX,AI,0.04,
MINMAX,SEAD,0.04,
MINMAX,DCA,0.03,
,MTRXPP,30.0,360.0,
,DPLYPP,30.0,360.0,
,HITRPT,0.0,360.0
,PRTSPP,0.0,360.0
ATBRPT,528,
CANNIB,ACF,0.0,2,1,10,
,MISNPP,
```

The first portioin of the changecard defines the warm up period and length of simulation.
The change card is also where the user defines the reports he wants created.
The cannibalization policy is also defined in this top portion

---

```
AUTH,ACF,18,
STORAC,ACF,SEAD,11,COCKED,
STORAC,ACF,DCA,7,COCKED,
,STORAC,ACF,CLEAN,2,AVAILABLE,
AUTH,27Z00,4
```

The number of aircraft, their pre-configurations and the number of spare engines are defined here

---

```
,*******************************************
,MANP0WER BY AFSC
,*******************************************
,FLIGHTLINE CREW CHIEF
SAUTH,2A3X3,6,1,
SAUTH,2A3X3,18,2,
SAUTH,2A3X3,18,3,
,*******************************************
,FLIGHTLINE ENGINES
SAUTH,2A6X1,2,1,
SAUTH,2A6X1,3,2,
SAUTH,2A6X1,3,3,
,*******************************************
,FLIGHTLINE ELECTRICS/ENVIRONMENTAL
SAUTH,2A6X6,2,1,
SAUTH,2A6X6,3,2,
SAUTH,2A6X6,3,3,
,*******************************************
,FLIGHTLINE ATTACK CONTROL
SAUTH,2A3X2,3,1,
SAUTH,2A3X2,6,2,
SAUTH,2A3X2,6,3,
,*******************************************
```

Authorized or assigned manpower numbers were modified in this part of the changecard. Note the AFSC, Number per shift, and Shift assignment. (1 = Mids, 2 = Days, 3 = Swings)

```
,FLIGHTLINE WEAPONS MAINTENANCE
SAUTH,2W1X1,2,     1,
SAUTH,2W1X1,4,     2,
SAUTH,2W1X1,3,     3,
,*****************************************
,FLIGHTLINE WEAPONS LOADERS
SAUTH,2W1L1,5,     1,
SAUTH,2W1L1,12,     2,
SAUTH,2W1L1,12,     3,
,*****************************************
,CRS ELECTRICS/ENVIRONMENTAL
SAUTH,2A6S6,0,     1,
SAUTH,2A6S6,4,     2,
SAUTH,2A6S6,4,     3,
,*****************************************
,CRS FUELS
SAUTH,2A6S4,3,     1,
SAUTH,2A6S4,4,     2,
SAUTH,2A6S4,4,     3,
,*****************************************
,CRS EGRESS
SAUTH,2A6S3,3,     1,
SAUTH,2A6S3,3,     2,
SAUTH,2A6S3,3,     3,
,*****************************************
,CRS HYDR0
SAUTH,2A6S5,0,     1,
SAUTH,2A6S5,2,     2,
SAUTH,2A6S5,2,     3,
,*****************************************
,CRS ENGINE ACCESSORIES
SAUTH,2A6M1,2,     1,
SAUTH,2A6M1,2,     2,
SAUTH,2A6M1,2,     3,
,*****************************************
,CRS ENGINE SUPPORT
SAUTH,2A6E1,2,     1,
SAUTH,2A6E1,2,     2,
SAUTH,2A6E1,2,     3,
,*****************************************
,CRS JEIM
SAUTH,2A6S1,2,     1,
SAUTH,2A6S1,2,     2,
SAUTH,2A6S1,2,     3,
,*****************************************
,CRS ENGINE TEST CELL
SAUTH,2A6T1,0,     1,
SAUTH,2A6T1,3,     2,
SAUTH,2A6T1,2,     3,
,*****************************************
,CRS ELECTRONIC WARFARE
SAUTH,2A1S7,2,     1,
SAUTH,2A1S7,2,     2,
SAUTH,2A1S7,2,     3,
,*****************************************
```

```
,CRS SENSOR/LANTIRN
,SAUTH,2A1S1,1,    1,
,SAUTH,2A1S1,2,    2,
,SAUTH,2A1S1,2,    3,
,*****************************************
,CRS AVIONICS TEST STATIONS
SAUTH,2A0S1,2,    1,
SAUTH,2A0S1,3,    2,
SAUTH,2A0S1,3,    3,
,*****************************************
,EMS SURVIVAL EQUIPMENT
SAUTH,2A7S4,0,    1,
SAUTH,2A7S4,4,    2,
SAUTH,2A7S4,0,    3,
,*****************************************
,EMS METALS TECH
SAUTH,2A7S1,1,    1,
SAUTH,2A7S1,2,    2,
SAUTH,2A7S1,2,    3,
,*****************************************
,EMS NDI
SAUTH,2A7S2,1,    1,
SAUTH,2A7S2,1,    2,
SAUTH,2A7S2,1,    3,
,*****************************************
,EMS STRUCTURAL REPAIR
SAUTH,2A7S3,3,    1,
SAUTH,2A7S3,4,    2,
SAUTH,2A7S3,4,    3,
,*****************************************
,EMS STRUCTURAL REPAIR
SAUTH,2A7X3,3,    1,
SAUTH,2A7X3,4,    2,
SAUTH,2A7X3,4,    3,
,*****************************************
,EMS STRUCTURAL REPAIR
SAUTH,2A7C3,3,    1,
SAUTH,2A7C3,4,    2,
SAUTH,2A7C3,4,    3,
,*****************************************
,EMS ARMAMENT SHOP
SAUTH,2W1S1,0,    1,
SAUTH,2W1S1,3,    2,
SAUTH,2W1S1,3,    3,
,*****************************************
,EMS WHEEL & TIRE
SAUTH,2A3W3,1,    1,
SAUTH,2A3W3,1,    2,
SAUTH,2A3W3,2,    3,
,*****************************************
,PHASE APG
SAUTH,2A3P3,0,    1,
SAUTH,2A3P3,7,    2,
SAUTH,2A3P3,7,    3,
,*****************************************
```

```
,LANDING GEAR TCTO'S
SAUTH,2A3T3,0,    1,
SAUTH,2A3T3,4,    2,
SAUTH,2A3T3,4,    3,
,*****************************************
,2B0GS
SAUTH,2B0GS,0,    1,
SAUTH,2B0GS,10,    2,
SAUTH,2B0GS,10,    3,
,*****************************************
```

```
AUTH,11AAF,  7
AUTH,11ABA,  7
AUTH,11CAF,  6
AUTH,11CEA,  7
AUTH,11EDD,  6
AUTH,11EDJ,  7
AUTH,11EDR,  7
AUTH,11EEF,  6
AUTH,11EEL,  7
AUTH,11EFE,  6
AUTH,11GAH,  7
AUTH,11GAR,  7
AUTH,11GAS,  6
AUTH,11GBH,  7
AUTH,11GBK,  6
AUTH,11GCK,  7
AUTH,11GDC,  7
AUTH,11GDD,  6
AUTH,11GDE,  7
AUTH,11GDJ,  7
AUTH,11GDR,  7
AUTH,11GDS,  6
AUTH,11GEB,  6
AUTH,11GEJ,  7
AUTH,11GGP,  7
AUTH,11JCA,  6
AUTH,11JCB,  7
AUTH,11JDA,  7
AUTH,11LAK,  7
AUTH,11LBE,  6
AUTH,11LDA,  7
AUTH,11LEA,  6
AUTH,11LEF,  7
AUTH,11MAG,  6
AUTH,11MDA,  6
AUTH,11MEA,  7
AUTH,11MEF,  7
AUTH,11MEM,  6
AUTH,12AAA,  7
AUTH,12AAF,  6
AUTH,12AAH,  7
AUTH,12AAJ,  6
AUTH,12ABA,  7
AUTH,12ACA,  7
```

Quantities of spare parts on the shelf at Cannon were modified here to bring the baseline models to NMCS rate to the squadron's fy2002 level. Note, parts on the shelf are annotated by a five digit Work Unit Code.

AUTH,12ACB, 6
AUTH,12ADA, 7
AUTH,12ADB, 7
AUTH,12AEB, 7
AUTH,12AED, 7
AUTH,12AEF, 6
AUTH,12AEG, 6
AUTH,12AFB, 6
AUTH,12AFE, 7
AUTH,12AFF, 7
AUTH,12AFG, 6
AUTH,12AGA, 7
AUTH,12AGB, 6
AUTH,12AHB, 7
AUTH,12C99, 7
AUTH,12CA0, 6
AUTH,12CAC, 7
AUTH,12CAG, 7
AUTH,12CAH, 6
AUTH,12CBB, 7
AUTH,12CCA, 7
AUTH,12CEA, 6
AUTH,12CGA, 7
AUTH,12DCB, 7
AUTH,12EAA, 6
AUTH,12EAC, 7
AUTH,12EAD, 6
AUTH,12EAE, 7
AUTH,12EF0, 6
AUTH,12EHA, 7
AUTH,12EJA, 7
AUTH,13AAC, 7
AUTH,13AAD, 6
AUTH,13B00, 7
AUTH,13BAB, 7
AUTH,13BAB1, 7
AUTH,13BAC, 6
AUTH,13BAC1, 7
AUTH,13BAC2, 7
AUTH,13BAC3, 7
AUTH,13BAD, 6
AUTH,13BAD1, 7
AUTH,13BAD2, 7
AUTH,13BAD3, 7
AUTH,13BAE1, 6
AUTH,13BAE2, 7
AUTH,13BAE3, 7
AUTH,13BAF1, 6
AUTH,13BAF2, 7
AUTH,13BAG, 6
AUTH,13BAH, 6
AUTH,13BAJ, 7
AUTH,13BAJ1, 7
AUTH,13BAK, 7
AUTH,13BAK1, 7
AUTH,13BAL, 6
AUTH,13BAN, 7
AUTH,13BAQ1, 6
AUTH,13BAR1, 7
AUTH,13BBE, 7
AUTH,13BBF, 6
AUTH,13BBJ, 7
AUTH,13BBR1, 7
AUTH,13BBS1, 6
AUTH,13BCA, 7
AUTH,13BCB, 7
AUTH,13BCF, 6
AUTH,13BCH, 6
AUTH,13BDA, 7
AUTH,13BDB, 7
AUTH,13BDC, 6
AUTH,13BDD, 7
AUTH,13BDF, 7
AUTH,13BDG, 6
AUTH,13CA1, 7
AUTH,13CA2, 7
AUTH,13CAA, 6
AUTH,13CAB1, 7
AUTH,13CAG, 7
AUTH,13CAG1, 6
AUTH,13CBA, 7
AUTH,13CCB, 7
AUTH,13CCC, 6
AUTH,13DA0, 7
AUTH,13DB0, 7
AUTH,13E00, 6
AUTH,13EAA, 7
AUTH,13EAB, 6
AUTH,13EAD, 7
AUTH,13EAF, 6
AUTH,13EAG, 7
AUTH,13EAH, 7
AUTH,13EAU, 6
AUTH,13EAZ, 7
AUTH,13FAA, 7
AUTH,13FAE, 6
AUTH,13G00, 7
AUTH,13GAA, 7
AUTH,13GAF, 7
AUTH,14AA0, 6
AUTH,14AD0, 6
AUTH,14AE0, 7
AUTH,14AED, 7
AUTH,14AF0, 7
AUTH,14AG0, 6
AUTH,14AR0, 7
AUTH,14BA0, 6
AUTH,14BB0, 7
AUTH,14BC0, 7
AUTH,14CA0, 7
AUTH,14CB0, 6
AUTH,14CBB, 7
AUTH,14D00, 7
AUTH,14DA0, 6
AUTH,14DAA, 7
AUTH,14DAC, 6
AUTH,14DAH, 7
AUTH,14DC0, 7
AUTH,14DFA, 6
AUTH,14DFE, 7
AUTH,14DH0, 7
AUTH,14DL0, 6
AUTH,14DM0, 7
AUTH,14ED0, 7
AUTH,14EF0, 7
AUTH,14EGA, 7
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AUTH,14FC0, 6
AUTH,14FD0, 6
AUTH,14FG0, 7
AUTH,14GA0, 7
AUTH,14GB0, 6
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AUTH,24AA0, 6
AUTH,24AAB, 7
AUTH,24AC0, 7
AUTH,24AD0, 7
AUTH,24BA0, 6
AUTH,24BAC, 7
AUTH,24BAD, 7
AUTH,24BAE, 6
AUTH,24BAF, 7
AUTH,24BD0, 7
AUTH,24BE0, 6
AUTH,24CB0, 7
AUTH,24DA0, 7
AUTH,24DAA, 6
AUTH,24DBA, 7
AUTH,24DBB, 7
AUTH,24DBF, 6
AUTH,24DC0, 7
AUTH,24DDA, 6
AUTH,24DDD, 7
AUTH,24DDE, 7
AUTH,24DDJ, 7
AUTH,24DDL, 6
AUTH,24DDN, 7
AUTH,24DEA, 7
AUTH,24DFB, 7
AUTH,24DFD, 7
AUTH,24DGC, 7
AUTH,24DGD, 6
AUTH,24EA0, 7
AUTH,24EAB, 7
AUTH,24EAD, 6
AUTH,24EAH, 7
AUTH,24EAM, 7
AUTH,24EBA, 6
AUTH,24EC0, 7
AUTH,271AC, 7
AUTH,271AH, 7
AUTH,271AJ, 6
AUTH,271AK, 7
AUTH,271AL, 7
AUTH,271BK, 6
AUTH,271BL, 7
AUTH,271BR, 6
AUTH,271BS, 7
AUTH,271DL, 7
AUTH,271DM, 6
AUTH,271DN, 7
AUTH,271DP, 6
AUTH,271EE, 7
AUTH,271EF, 7
AUTH,271F0, 7
AUTH,271FB, 6
AUTH,271HB, 7
AUTH,27ACA, 7
AUTH,27AG0, 6
AUTH,27AGA, 7
AUTH,27AH0, 6
AUTH,27AN0, 7
AUTH,27BFA, 6
AUTH,27EAD, 7
AUTH,27EAL, 7
AUTH,27EAM, 6
AUTH,27EAN, 7
AUTH,27EAP, 7
AUTH,27EAS, 7
AUTH,27EC0, 6
AUTH,27ECP, 7
AUTH,27EDA, 7
AUTH,27EDB, 6
AUTH,27EDL, 7
AUTH,27GAA, 6
AUTH,27GAD, 7
AUTH,27GAH, 7
AUTH,27GAL, 6
AUTH,27GAW, 7
AUTH,27GAX, 7
AUTH,27GBB, 6
AUTH,27GBF, 7
AUTH,27GDC, 7
AUTH,27GDH, 6
AUTH,27GDP, 7
AUTH,27GJH, 7
AUTH,27GJV, 6
AUTH,27GJY, 7
AUTH,27GMC, 6
AUTH,27GMD, 6

AUTH,27GP*, 7
AUTH,27GPH, 7
AUTH,27GPJ, 7
AUTH,27GPK, 6
AUTH,27GPL, 7
AUTH,27GPM, 7
AUTH,27GPN, 6
AUTH,27GPP, 7
AUTH,27GPQ, 7
AUTH,27GPT, 6
AUTH,27GPU, 7
AUTH,27GPV, 7
AUTH,27GSA, 7
AUTH,27GSB, 6
AUTH,27GSC, 7
AUTH,27GSE, 7
AUTH,27GSF, 6
AUTH,27GT0, 7
AUTH,27GTA, 6
AUTH,27GTL, 6
AUTH,27Z00, 7
AUTH,41AAA, 7
AUTH,41AAB, 6
AUTH,41AAD, 7
AUTH,41AAE, 7
AUTH,41AAF, 7
AUTH,41AAL, 7
AUTH,41AAQ, 6
AUTH,41AAS, 7
AUTH,41ABD, 7
AUTH,41ABE, 7
AUTH,41ABF, 6
AUTH,41ABM, 7
AUTH,41ABN, 7
AUTH,41ACA, 6
AUTH,41ACK, 7
AUTH,41ADA, 7
AUTH,41ADB, 6
AUTH,41ADH, 7
AUTH,41ADL, 7
AUTH,41ADM, 7
AUTH,41BBA, 6
AUTH,41BBD, 7
AUTH,41CBA, 7
AUTH,42A00, 6
AUTH,42AA0, 7
AUTH,42AAD, 6
AUTH,42ACA, 6
AUTH,42AE0, 7
AUTH,42AJ0, 7
AUTH,42AK0, 6
AUTH,42AN0, 7
AUTH,42CB0, 7
AUTH,42DBC, 7
AUTH,42EA0, 7
AUTH,42EB0, 6
AUTH,42GAA, 7
AUTH,42GB0, 7
AUTH,42HC0, 6
AUTH,42HCE, 7
AUTH,42JA0, 7
AUTH,42JBA, 6
AUTH,44AAA, 7
AUTH,44AAB, 7
AUTH,44AAC, 7
AUTH,44AAD, 7
AUTH,44AAE, 6
AUTH,44AAF, 7
AUTH,44AAG, 7
AUTH,44AAH, 6
AUTH,44AAJ, 7
AUTH,44AAK, 6
AUTH,44AB0, 7
AUTH,44AC0, 7
AUTH,44BA0, 7
AUTH,44BAA, 6
AUTH,44BB0, 7
AUTH,44BC0, 7
AUTH,44BD0, 7
AUTH,44BE0, 6
AUTH,44CA0, 6
AUTH,44CB0, 7
AUTH,44CH0, 7
AUTH,45AAA, 6
AUTH,45AAB, 7
AUTH,45AAC, 7
AUTH,45AAD, 6
AUTH,45AAE, 7
AUTH,45ACA, 7
AUTH,45ACB, 7
AUTH,45AEB, 6
AUTH,45AEN, 7
AUTH,45AG0, 6
AUTH,45AH0, 7
AUTH,45AJ0, 7
AUTH,45AJA, 7
AUTH,45AK0, 7
AUTH,45AKA, 6
AUTH,45AL0, 7
AUTH,45ALA, 7
AUTH,45BAB, 7
AUTH,46AB0, 6
AUTH,46AC0, 7
AUTH,46AE0, 7
AUTH,46AF0, 7
AUTH,46AFA, 7
AUTH,46AGA, 6
AUTH,46AH0, 7
AUTH,46AJ0, 7
AUTH,46AK0, 6
AUTH,46AMA, 7
AUTH,46AN0, 7
AUTH,46AP0, 6
AUTH,46APA, 7
AUTH,46AV0, 7
AUTH,46BAA, 7
AUTH,46BB0, 7
AUTH,46BC0, 6
AUTH,46BD0, 7
AUTH,46BFA, 7
AUTH,46BHA, 7
AUTH,46BRA, 7
AUTH,46BT0, 6
AUTH,46BU0, 7
AUTH,46BV0, 6
AUTH,46BW0, 7
AUTH,46BX0, 7
AUTH,46BY0, 6
AUTH,46C00, 7
AUTH,46CA0, 7
AUTH,46CB0, 6
AUTH,46CCA, 7
AUTH,46CDA, 7
AUTH,46CEA, 6
AUTH,46CHA, 7
AUTH,46CKA, 7
AUTH,46CN0, 6
AUTH,46CP0, 7
AUTH,46DA0, 7
AUTH,46DAA, 6
AUTH,46DAB, 7
AUTH,46DB0, 7
AUTH,46DG0, 7
AUTH,46DHA, 6
AUTH,46EB0, 7
AUTH,46EC0, 7
AUTH,46ED0, 6
AUTH,46EE0, 7
AUTH,46EG0, 6
AUTH,46EJ0, 7
AUTH,46EMA, 7
AUTH,46EP0, 6
AUTH,46EQA, 7
AUTH,46EUA, 7
AUTH,46EV0, 7
AUTH,46EY0, 6
AUTH,46F00, 7
AUTH,46FA0, 7
AUTH,46FAA, 6
AUTH,46FAH, 7
AUTH,46FCC, 7
AUTH,46FD0, 7
AUTH,46FE0, 6
AUTH,46FEF, 7
AUTH,46FEJ, 7
AUTH,47AAA, 6
AUTH,47ABC, 7
AUTH,47ABD, 7
AUTH,47ABF, 7
AUTH,47AD0, 6
AUTH,47AE0, 7
AUTH,49AA0, 7
AUTH,49ABA, 6
AUTH,49ABB, 7
AUTH,49ABD, 6
AUTH,49BBB, 7
AUTH,49BBC, 7
AUTH,49BBE, 6
AUTH,51AA0, 7
AUTH,51AB0, 7
AUTH,51AC0, 7
AUTH,51BA0, 6
AUTH,51BB0, 7
AUTH,51BC0, 6
AUTH,51CB0, 7
AUTH,51CC0, 7
AUTH,51DA0, 7
AUTH,51DB0, 7
AUTH,51EAD, 6
AUTH,51FA0, 7
AUTH,55DB0, 7
AUTH,62CD0, 7
AUTH,63BM0, 6
AUTH,63CBA, 7
AUTH,63CBB, 7
AUTH,64AD0, 7
AUTH,65AA0, 6
AUTH,69AA0, 7
AUTH,69AB0, 6
AUTH,69AC0, 7
AUTH,71AA0, 7
AUTH,71AB0, 6
AUTH,71AF0, 6
AUTH,71BA0, 7
AUTH,71BD0, 6
AUTH,74AM0, 7
AUTH,74AN0, 7
AUTH,74AP0, 7
AUTH,74AQ0, 6
AUTH,74AS0, 7
AUTH,74AU0, 7
AUTH,74BE0, 7
AUTH,74BP0, 6
AUTH,74BQ0, 7
AUTH,74BQP, 7
AUTH,74BR0, 7
AUTH,74CC0, 6
AUTH,74DF0, 7
AUTH,74DG0, 7
AUTH,74GA0, 6

```
AUTH,74GAB,  7
AUTH,74GB0,  7
AUTH,74HA0,  7
AUTH,74JA0,  6
AUTH,74JB0,  7
AUTH,74JC0,  6
AUTH,74JF0,  7
AUTH,74KA0,  7
AUTH,74KB0,  6
AUTH,74LA0,  7
AUTH,74Z00,  7
AUTH,75AA0,  7
AUTH,75AAD,  6
AUTH,75ABA,  7
AUTH,75BA0,  7
AUTH,75BB0,  7
AUTH,75BD0,  7
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AUTH,75CJ0,  7
AUTH,75CK0,  7
AUTH,75CL0,  7
AUTH,75CN0,  6
AUTH,75CP0,  7
AUTH,75DD0,  7
AUTH,75DJ0,  6
AUTH,75EC0,  7
AUTH,75ED0,  7
AUTH,76BA0,  6
AUTH,76CE0,  6
AUTH,76DC0,  7
AUTH,76DD0,  7
AUTH,76DG0,  7
AUTH,76EA0,  7
AUTH,76EB0,  6
AUTH,76EC0,  7
AUTH,76ED0,  7
AUTH,76EE0,  7
AUTH,76EG0,  7
AUTH,76EK0,  6
AUTH,76EL0,  7
AUTH,76EW0,  7
AUTH,97AM0,  7
AUTH,97AN0,  6
AUTH,97AP0,  7
AUTH,97AS0,  7
AUTH,97AT0,  7
AUTH,97AU0,  7
AUTH,97AV0,  7
AUTH,97BY0,  6
AUTH,97BYB,  6
AUTH,97CD0,  7
AUTH,97CG0,  6
AUTH,97CH0,  7
AUTH,97EAA,  7
AUTH,97EAB,  7
AUTH,97EAC,  6
AUTH,97EAE,  7
AUTH,97EAF,  7
AUTH,97EAG,  7
AUTH,97EAK,  7
AUTH,97EAL,  7
AUTH,AAIS ,  2
AUTH,MULE ,  1
AUTH,RACFT,  1
STOP,390.0
```

Appendix C. Forms 30 – 75 Example

```
C30  *************************************
C30   SEAD to DCA
 30 REC270                    REC272  D
C30 REC271   L0AD_2_AIM120      REC272  D
 30 REC272   L0AD_2_AIM9        REC273  E .500
 30 REC272   JN0_L0AD           REC273  E .500
 30 REC273   D_L0AD_PYL_TER_CBU         E .950
 30 REC273   D_L0AD_LAU_AGM65           E .050
C30 REC273   D_L0AD_LAU_AGM88           E .600
C30  *************************************
C30    PST_SEAD to SEAD
 30 REC300                    REC301  GEICT     1
 30 REC300                    REC302  LSICT     1
 30 REC301   L0ADED                   D
 30 REC302                    REC303  D
C30 REC303   L0AD_AGM88         REC304  E .150
 30 REC303   L0AD_AGM65         REC304  E .200
 30 REC303   L0AD_CBU           REC304  E .050
 30 REC303   JN0_L0AD           REC304  E .750
 30 REC304   L0AD_1_AIM9        REC305  E .050
 30 REC304   L0AD_2_AIM9        REC305  E .050
C30 REC304   L0AD_2_AIM120      REC305  E .050
 30 REC304   JN0_L0AD           REC305  E .900
 30 REC305   L0AD_20MM          REC306  E .020
 30 REC305   JN0_L0AD           REC306  E .980
 30 REC306   L0AD_CHF_FLR               A .400
 30 REC306   L0AD_TANKS                 A .050
```

Form 30: Reconfiguration networks.

```
45 *         8   8   8   12  12
45 R               5       2
45   2A0S1    200 200 200 5   000
45   2A1S7    200 200 200 5   000
45   2A3X2    200 200 200 5   000
45   2A3P3    200 200 200 5   000
45   2A3T3    200 200 200 5   000
45   2A3W3    200 200 200 5   000
45   2A3X3    200 200 200 5   000
45   2A6E1    200 200 200 5   000
45   2A6M1    200 200 200 5   000
45   2A6S1    200 200 200 5   000
45   2A6S3    200 200 200 5   000
45   2A6S4    200 200 200 5   000
45   2A6S5    200 200 200 5   000
45   2A6S6    200 200 200 5   000
45   2A6T1    200 200 200 5   000
45   2A6X1    200 200 200 5   000
45   2A6X6    200 200 200 5   000
45   2A7C3    200 200 200 5   000
```

Form 45: Manpower and Shift Philosophy. In this scenario there are 200 people authorized on each shift (Monday through Friday) and 5 people authorized on Saturday (0 on Sunday). Mon through Fri are 8-hour shifts; Sat and Sun are 12-hour shifts. Authorized or assigned numbers were changed by making input via changecard (Appendix B).

```
45   2A7S1    200 200 200 5   000
45   2A7S2    200 200 200 5   000
45   2A7S3    200 200 200 5   000
45   2A7S4    200 200 200 5   000
45   2A7X3    200 200 200 5   000
45   2B0GS    200 200 200 5   000
45   2W1S1    200 200 200 5   000
45   2W1X1    200 200 200 5   000
45   2W1L1    200 200 200 5   000
45   GENSB    0   0
45   2CHIP    200 200 200 5   000
```

```
50
5001 10
5002 20
5003 30
5004 3     2     1
5005 .25   .50   .75
5006 2.0   2.0   2.0
5007 20    48    48
5008 1.0
5009 1.0
5010 5
```

Form 50: Models 2 hours of overtime per shift

```
55
C55 CAS       MN0001   CAS     PST_CAS  SP_CAS   ACF
C55 AI        MN0001   AI      PST_AI   SP_AI    ACF
 55 DCA       MN0001   DCA     PST_DCA  SP_DCA   ACF
 55 SEAD      MN0001   SEAD    PST_SEAD SP_SEAD  ACF
 55 DAYA      A DAYA                    ACF
 55 DAYW      A DAYW                    ACF
 55 TAC9      A TAC9                    ACF
 55 TAC6      A TAC6                    ACF
 55 PAINT     A PAINT                   ACF
 55 WASH      A WASH                    ACF
 55 DAYN      N DAYN                    SCHED
```

Form 55: Missions and scheduled maintenance identifiers

```
60
60 SP_DCA    C DCA
 60       C A DCA                       0.1
C60       C C FLY_DCA       DCA_DNF
C60       C A FLY_DCA       DCA_DNF          0.1
 60       C A PST_DCA  REC200           0.1
C60       C A PST_CAS  REC220           0.1
C60       C A PST_AI   REC230           0.1
 60       C A PST_SEAD REC240           0.1
C60       C A CAS      REC250           0.1
C60       C A AI       REC260           0.1
 60       C A SEAD     REC270           0.1
```

Form 60: Aircraft search patterns

```
C60      C C CAS     REC250           0.1
C60      C C AI      REC260           0.1
 60      C C SEAD    REC270           0.1
 60 SP_SEAD   C SEAD
 60      C A SEAD                 0.1
C60      C C FLY_SEAD      SEAD_DNF
C60      C A FLY_SEAD      SEAD_DNF        0.1
 60      C A PST_SEAD REC300           0.1
C60      C A PST_CAS  REC310           0.1
C60      C A PST_AI   REC320           0.1
 60      C A PST_DCA  REC330           0.1
C60      C A CAS     REC340           0.1
C60      C A AI      REC350           0.1
 60      C A DCA     REC360           0.1
C60      C C CAS     REC340           0.1
C60      C C AI      REC350           0.1
 60      C C DCA     REC360           0.1
C ***********************************************************************
```

```
 75
 75 1   1   0800 ACF    SEAD   2 4  1 1.4H  0   C7.0 1.0 1007999
 75 1   1   0830 ACF    SEAD   2 2  1 1.4H  0   C7.0 1.0 1007999
 75 1   1   0900 ACF    DCA    2 4  1 1.4H  0   C8.0 1.0 1007999
 75 1   1   1600 ACF    SEAD   2 4  1 1.4H  0   C7.0 1.0 1007999
 75 1   1   1630 ACF    SEAD   2 2  1 1.4H  0   C7.0 1.0 1007999
 75 1   1   1700 ACF    DCA    2 4  1 1.4H  0   C8.0 1.0 1007999
C75 1   1   0900 ACF    DAYW    1                 2001999
 75 1   1   1800 SCHED  DAYN    1                 2007999
 75 1   1   0715 ACF    PAINT   1                 2042999
 75 1   1   1900 ACF    DAYA   ALL                1007999
 75 2   1   0800 ACF    SEAD   2 4  1 1.4H  0   C7.0 1.0 1007999
 75 2   1   0830 ACF    SEAD   2 2  1 1.4H  0   C7.0 1.0 1007999
 75 2   1   0900 ACF    DCA    2 4  1 1.4H  0   C8.0 1.0 1007999
 75 2   1   1600 ACF    SEAD   2 4  1 1.4H  0   C7.0 1.0 1007999
 75 2   1   1630 ACF    SEAD   2 2  1 1.4H  0   C7.0 1.0 1007999
 75 2   1   1700 ACF    DCA    2 4  1 1.4H  0   C8.0 1.0 1007999
 75 2   1   1800 SCHED  DAYN    1                 2007999
 75 2   1   1900 ACF    DAYA   ALL                1007999
 75 3   1   0800 ACF    SEAD   2 4  1 1.4H  0   C7.0 1.0 1007999
 75 3   1   0830 ACF    SEAD   2 2  1 1.4H  0   C7.0 1.0 1007999
 75 3   1   0900 ACF    DCA    2 4  1 1.4H  0   C8.0 1.0 1007999
 75 3   1   1600 ACF    SEAD   2 4  1 1.4H  0   C7.0 1.0 1007999
 75 3   1   1630 ACF    SEAD   2 2  1 1.4H  0   C7.0 1.0 1007999
 75 3   1   1700 ACF    DCA    2 4  1 1.4H  0   C8.0 1.0 1007999
 75 3   1   1800 SCHED  DAYN    1                 2007999
 75 3   1   1900 ACF    DAYA   ALL                1007999
 75 4   1   0800 ACF    SEAD   2 4  1 1.4H  0   C7.0 1.0 1007999
 75 4   1   0830 ACF    SEAD   2 2  1 1.4H  0   C7.0 1.0 1007999
 75 4   1   0900 ACF    DCA    2 4  1 1.4H  0   C8.0 1.0 1007999
 75 4   1   1600 ACF    SEAD   2 4  1 1.4H  0   C7.0 1.0 1007999
```

Form 75: Sortie Generation data (i.e. Flying schedule and scheduled maintenance)

```
75 4    1    1630 ACF      SEAD    2 2   1 1.4H  0     C7.0 1.0 1007999
75 4    1    1700 ACF      DCA     2 4   1 1.4H  0     C8.0 1.0 1007999
75 4    1    1800 SCHED    DAYN     1                       2007999
75 4    1    1900 ACF      DAYA     ALL                     1007999
75 5    1    0800 ACF      SEAD    2 3   1 1.4H  0     C7.0 1.0 1007999
75 5    1    0830 ACF      SEAD    2 2   1 1.4H  0     C7.0 1.0 1007999
75 5    1    0900 ACF      DCA     2 2   1 1.4H  0     C8.0 1.0 1007999
75 5    1    1900 ACF      DAYA     ALL                     1007999
75 5    1    0900 ACF      WASH    1 1                     2014999
75 5    1    1800 SCHED    DAYN     1                       2007999
75 8    1    0800 ACF      TAC6    1 1                     2102999
75 30   1    0800 ACF      TAC9
```

Appendix D. Cannon's Excel Spreadsheet

522 FIGHTER SQUADRON F-16 HISTORY FY2002

STAT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	CURR FY
PAA	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
POSS HRS	14880.0	14400.0	16861.9	17100.0	15399.7	14731.3	12131.1	11890.0	11911.9	13126.3	12697.2	12558.9	167688.3
AVG POSS ACFT	20.0	20.0	22.7	23.0	22.9	19.8	16.8	16.0	16.5	17.6	17.1	17.4	19.1
MC HRS	11424.1	11648.2	12610.6	14865.4	12922.0	12264.7	9911.2	8980.5	10407.2	9310.6	8170.3	8087.8	130602.6
RATE/83%	76.8	80.9	74.8	86.9	83.9	83.3	81.7	75.5	87.4	70.9	64.3	64.4	77.9
FMC HRS	11133.7	11648.2	12610.6	14715.4	12656.3	11588.9	9844.7	8914.3	10407.2	9090.5	8147.9	8087.8	128845.5
RATE	74.8	80.9	74.8	86.1	82.2	78.7	81.2	75.0	87.4	69.3	64.2	64.4	76.8
NMC HRS	3455.9	2751.8	4251.3	2234.6	2477.8	2466.5	2220.0	2909.6	1504.8	3815.8	4526.8	4471.1	37086.0
RATE	23.2	19.1	25.2	13.1	16.1	16.7	18.3	24.5	12.6	29.1	35.7	35.6	22.1
TNMCM HRS	2218.8	1767.5	2364.8	1453.0	1542.2	1560.1	1267.0	1984.4	648.1	2799.5	3442.6	3750.4	24798.4
RATE/10%	14.9	12.3	14.0	8.5	10.0	10.6	10.4	16.7	5.4	21.3	27.1	29.9	14.8
TNMCS HRS	1906.8	1531.1	3012.8	1074.8	1237.4	1277.7	1255.0	1548.8	884.7	1938.4	2235.6	1985.9	19889.0
RATE/8%	12.8	10.6	17.9	6.3	8.0	8.7	10.3	13.0	7.4	14.8	17.6	15.8	11.9
ACTUAL UTE	24.6	16.1	17.7	18.2	22.8	15.4	18.2	19.3	13.8	18.9	15.8	17.1	18.2
AVG SRT DUR	1.3	1.3	1.6	1.7	1.4	1.3	1.6	1.5	2.5	1.3	1.3	1.7	1.5
SCH FLYHRS	588.6	444.2	465.8	814.5	732.4	697.7	521.1	511.2	712.3	509.9	514.4	415.9	6918.5
TOT HRS FLWN	583.4	377.3	524.7	545.0	573.9	363.6	527.6	534.5	632.5	426.5	363.4	521.7	5974.1
SORT FLWN	442	290	319	327	411	277	327	348	249	340	285	307	3922
TOT SCHD SORT	436	329	345	384	466	327	431	387	271	384	381	348	4489

523 FIGHTER SQUADRON F-16 HISTORY FY 2002

STAT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	CURR FY
PAA	18.0	18.0	15.0	14.0	14.0	15.0	18.0	18.0	18.0	18.0	18.0	18.0	16.8
POSS HRS	12095.5	12776.7	11088.0	10416.0	9408.0	12362.9	13421.7	13270.1	12536.7	11901.8	12273.7	12683.1	144234.2
AVG POSS ACFT	16.3	17.7	14.9	14.0	14.0	16.6	18.6	17.8	17.4	16.0	16.5	17.6	16.5
MC HRS	9575.8	10078.8	9463.5	8786.5	7997.1	10151.4	10818.8	10197.8	9605.9	9026.7	6958.9	9169.7	111830.9
RATE/83%	79.2	78.9	85.3	84.4	85.0	82.1	80.6	76.8	76.6	75.8	56.7	72.3	77.5
FMC HRS	9011.7	10010.0	9463.5	8419.4	7997.1	10109.6	10470.9	10037.8	9605.9	8711.9	6519.9	8959.9	109317.6
RATE	74.5	78.3	85.3	80.8	85.0	81.8	78.0	75.6	76.6	73.2	53.1	70.6	75.8
NMC HRS	2519.7	2697.9	1624.5	1629.6	1410.9	2211.4	2602.9	3072.3	2930.8	2875.1	5314.8	3513.4	32403.3
RATE	20.8	21.1	14.7	15.6	15.0	17.9	19.4	23.2	23.4	24.2	43.3	27.7	22.5
TNMCM HRS	1779.2	1743.8	837.0	1274.4	928.3	1603.0	1767.7	2303.4	1822.1	2049.5	4235.1	3063.4	23406.9
RATE10%	14.7	13.6	7.5	12.2	9.9	13.0	13.2	17.4	14.5	17.2	34.5	24.2	16.2
TNMCS HRS	1764.9	1329.7	1064.9	846.3	938.1	845.8	1164.0	1042.4	1680.2	998.1	2138.8	1132.0	14945.2
RATE/8%	14.6	10.4	9.6	8.1	10.0	6.8	8.7	7.9	13.4	8.4	17.4	8.9	10.4
ACTUAL UTE	24.8	14.1	14.9	19.2	18.4	13.2	24.8	24.6	19.7	18.7	16.7	13.8	18.7
AVG SRT DUR	1.2	1.6	3.2	2.7	2.8	2.6	1.3	1.3	1.5	1.6	5.1	1.3	2.0
SCH FLYHRS	635.9	405.0	338.9	727.7	717.8	626.5	627.7	646.4	560.8	564.6	1533.2	388.1	7764.5
TOT HRS FLWN	529.4	412.3	719.3	727.7	717.8	521.2	591.8	569.5	517.3	526.6	1533.2	330.6	7696.7
SORT FLWN	447	254	224	269	258	198	447	442	355	336	300	248	3778
TOT SCHD SORT	471	300	251	300	279	218	472	468	372	361	306	294	4092

524 FIGHTER SQUADRON (block 40) F-16 HISTORY FY2002

STAT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	CURR FY
PAA	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
POSS HRS	15064.3	16883.4	19007.2	18600.0	16796.4	18104.5	18000.0	18887.4	18154.1	18949.7	18562.5	17701.9	214711.4
AVG POSS ACFT	20.2	23.4	25.5	25.0	25.0	24.3	25.0	25.4	25.2	25.5	24.9	24.6	24.5
MC HRS	12132.2	13677.5	15179.7	15159.0	13083.5	14454.8	14981.1	15044.8	14727.3	14901.7	12664.3	12582.9	168588.8
RATE/83%	80.5	81.0	79.9	81.5	77.9	79.8	83.2	79.7	81.1	78.6	68.2	71.1	78.5
FMC HRS	11257.8	13036.3	14361.6	14993.8	13066.1	14384.7	14981.1	14637.3	12537.4	13948.6	11111.9	12279.5	160596.1
RATE	74.7	77.2	75.6	80.6	77.8	79.5	83.2	77.5	69.1	73.6	59.9	69.4	74.8
NMC HRS	2932.1	3205.9	3827.4	3441.0	3712.9	3649.6	3018.9	3842.6	3426.8	4048.0	5898.1	5119.1	46122.4
RATE	19.5	19.0	20.1	18.5	22.1	20.2	16.8	20.3	18.9	21.4	31.8	28.9	21.5
TNMCM HRS	1780.0	2078.5	2647.7	2172.1	2584.8	2100.9	1905.7	2281.4	2115.1	2831.2	3734.4	3842.0	30073.8
RATE/10%	11.8	12.3	13.9	11.7	15.4	11.6	10.6	12.1	11.7	14.9	20.1	21.7	14.0
TNMCS HRS	1266.1	2139.9	1759.2	1368.5	1670.8	2335.7	1619.7	1863.5	1612.6	1625.7	2635.9	1962.9	21860.5
RATE/8%	8.4	12.7	9.3	7.4	9.9	12.9	9.0	9.9	8.9	8.6	14.2	11.1	10.2
ACTUAL UTE	18.1	15.8	13.7	18.3	18.7	18.3	21.7	19.8	17.8	20.9	19.5	13.4	18.0
AVG SRT DUR	1.5	1.5	1.4	1.3	1.3	1.5	1.5	1.4	1.3	1.3	1.4	1.3	1.4
SCH FLYHRS	623.7	644.0	473.0	668.4	611.1	849.6	768.7	633.8	590.0	649.2	629.6	431.3	7429.1
TOT HRS FLWN	640.8	566.3	461.7	564.3	598.2	665.4	770.8	661.7	545.0	655.7	662.7	414.5	7207.1
SORT FLWN	434	379	328	438	449	440	520	474	426	502	468	321	5179
TOT SCHD SORT	462	477	361	514	523	431	527	485	464	561	512	365	5682

Appendix E. Simulation SEEDS

The seed list below contains 75 rows (1 line for each replication) and eight columns (A through H). The eight columns represent the starting seed values for various parameters within the LCOM. Below is a list of the columns and their self-explanatory titles (ASC-LCOM,2000).

Column A: Attribute initial values
Column B: Task durations
Column C: Failure clock operations
Column D: Time accumulating attributes random setting
Column E: Probability of air abort, attrition, or ram repair
Column F: Task selection A, E, and G selection modes
Column G: Random multiplier for initial failure clock settings
Column H: Sortie length (task time option)

A	B	C	D	E	F	G	H
330847383	920646964	65982104	573275029	159001232	266507685	787433146	381822288
64658285	805640040	651725530	593876778	263699889	952899991	226791382	68142117
492515206	561620056	765133141	609610974	648626207	1734317	969448565	672690092
681312679	487903416	8255721	314325273	732237219	657639562	781517981	397126376
526070237	399431526	436269045	42492331	11114956	930869637	132237912	333736122
249932409	126770795	57473899	269209802	559966444	97303451	693971633	965429483
904168723	16112627	333296061	110200346	531623721	198444903	842207430	665741621
868173717	429273426	678286313	821811615	657043814	541422903	155558587	198832691
349466920	243694604	960120438	301016271	745308756	198991359	915763376	219487846
883692859	352442563	999599216	585411965	183625579	509529173	607685088	773117243
834621070	164208711	70648433	353221357	437326312	577040254	419312000	795756041
894146083	103309453	400318861	423292100	549867987	771153508	741757392	614064395
582287430	109686197	668786286	255096853	642832636	227122844	669259547	445327460
747189640	138905347	509351491	448733270	415927291	345827162	499181747	897455393
65122248	662158309	8440257	244924009	646983980	293770373	232012272	468983352
540479779	166261495	205603362	25016726	691959738	503081381	71364404	49071492
5781771	653656303	593516587	810984074	984936593	171514094	923976420	417504966
621672749	142409146	617980718	765423714	538121580	762447415	899711607	744693934
376922250	166211427	177921534	691558300	441846728	504885256	811558245	91673554
588424801	274379552	125389815	533235490	364569068	893456517	675629615	910103975
401199937	531854927	765561341	874927936	52870632	188415111	211163998	542270362
288392186	19203962	356736898	441733300	831458448	915639935	340524673	721082865
551271080	332618058	610342263	599374234	103164554	366634905	689199923	70076645
819231151	83913625	190928221	854198395	848945974	98528922	85803033	603411853
549791931	400532067	216170550	353178441	127884746	434075892	62072278	225873649
528597950	425539791	756870030	383912027	577187895	961654721	352870941	232872188
369418740	817628203	336952448	874621807	912187455	35269321	396187305	810442625
14148832	251113713	433468580	894155441	426340460	274548590	833134650	535245120
232807756	915937720	976594208	151985586	491228938	64746440	7951261	874564825
123540044	17666639	849630116	498209893	56559921	56741775	468000412	686311900

612615227 277491868 389002085 423551023 150165439 667038499 463770389 719021498
954427836 432229817 884260891 559356629 378002524 577765524 448874473 111853779
231497407 734321891 78082324 177599371 424153208 236676753 580050945 894593893
854468463 451834499 666267156 690876900 550824522 357151091 217163086 487652003
62110544 368459046 797741173 152411879 98348499 418192446 423199177 202063263
421318173 283511937 574555158 756051956 985182164 164429725 464272499 739487826
327110887 511934578 551884889 336269796 207907558 106116832 309621334 692210852
502633213 384293377 238031149 868163048 341231704 19132675 131608964 43142498
499154686 746779739 594419717 967454372 37986637 444981157 805723666 665817915
196069837 461210072 535601377 390491426 529129385 190791190 410578727 824397264
300898194 905025778 429251909 534246861 123741985 829316674 727912425 673665701
849284290 471293270 596172094 936318336 709031462 198936522 742588042 759033381
704997658 68703950 810287713 774928509 250329852 903654633 142593861 516535460
59932829 621574222 798649548 368925035 291094184 813099919 819043158 772832094
934109328 569845497 741433381 677780568 452906489 562526285 366174221 245208442
675671696 369084179 771939992 801592766 935473798 52812637 581350326 41574658
460889458 990481673 476595163 481084287 16628147 950462876 965059755 160465897
794157146 420854389 394949674 597602784 552326559 187605918 220915795 991042314
7994295 162643731 519679307 673120915 476651072 461995661 755656718 813089071
763045429 733916103 796584843 370236337 301808715 737011014 179145813 297016323
548080086 168362916 624592065 992171703 618131518 741655885 804371356 3859223
179992795 515300571 355751753 982774673 594076513 470559179 147446633 885277925
303803086 339670479 795239686 426517904 476225733 683974801 427609920 783557592
892655490 222039044 701356648 548499047 89286209 407781660 67224503 931608377
747819542 258597672 285528422 214440763 336089969 433483660 191778660 452965438
998689769 561162769 712305783 430690705 697594045 818209706 129885674 861788927
602785706 757175742 599364518 844221531 732880472 384713709 913283823 562864005
845751880 489702999 517505407 242630899 579156279 221374572 776836394 351600826
841357826 917435942 490654230 54141463 451753497 182196200 658531665 914034544
31498075 214690984 495861768 847600876 144129158 386807501 699482917 326825321
686192154 71409524 963303803 832481800 527865290 720462381 743928431 557258307
403584599 193157971 276281119 358881891 52668930 334039748 839231490 963243661
609944939 801127730 271219492 417523801 246372104 144043506 735880374 793316542
59667707 132135213 737669705 139755190 214931846 332602561 387488365 686637102
335272431 938621817 918307541 297548711 142430187 847470818 450793743 172990501
347403645 988653956 8933784 803502022 791074155 902027188 785659789 172786892
834830879 565923034 658474206 210837782 1195789 475275576 955074785 497061431
864448665 969745455 468979597 213403643 191252113 811844884 725152015 347474277
331276536 15062631 495625734 145672262 857825158 921989022 565129756 816310583
458459019 532440960 746713399 482741296 75621963 81586898 147371293 386480510
297265649 868071853 683668374 340333402 997474549 332142413 847364901 431519210
227090955 383771717 721041440 974796234 354339957 980784474 243723870 715586840
455454468 956981955 726508378 283102453 955300210 100266994 618186473 893468557
518000721 480768978 520869970 302849710 187562347 28968872 455615997 10574521
778499244 363824189 378051996 712260662 516458392 870894013 944000719 2939881

Appendix F. Raw Results of the 24 Scenarios

Squadron	Manning	O/T?	Parts?	Sorties	NMCS
522	AS	O	B	3902.00	13.39
522	AS	O	B	4098.00	3.87
522	AS	O	B	3614.00	17.9
522	AS	O	B	4000.00	9.37
522	AS	O	B	3565.00	20.97
522	AS	O	B	4034.00	7.61
522	AS	O	B	4124.00	3.79
522	AS	O	B	4135.00	1.59
522	AS	O	B	3496.00	21.62
522	AS	O	B	4122.00	4.8
522	AS	O	B	4158.00	2.53
522	AS	O	B	4051.00	3.45
522	AS	O	B	4149.00	4.98
522	AS	O	B	3557.00	20.29
522	AS	O	B	3393.00	26.1
522	AS	O	B	3902.00	9.81
522	AS	O	B	3761.00	15.92
522	AS	O	B	3862.00	12.19
522	AS	O	B	4152.00	1.01
522	AS	O	B	4208.00	1.68
522	AS	O	B	3692.00	19.86
522	AS	O	B	3076.00	32.66
522	AS	O	B	3813.00	16.13
522	AS	O	B	4181.00	2.21
522	AS	O	B	4159.00	1.53
522	AS	O	B	4078.00	4.86
522	AS	O	B	4157.00	2.07
522	AS	O	B	2886.00	35.81
522	AS	O	B	4079.00	5.43
522	AS	O	B	3857.00	13.46
522	AS	O	B	4189.00	2.57
522	AS	O	B	4041.00	8.85
522	AS	O	B	3391.00	26.45
522	AS	O	B	3970.00	8.21
522	AS	O	B	3847.00	12.81
522	AS	O	B	4201.00	2.06
522	AS	O	B	4194.00	2.03
522	AS	O	B	3420.00	25.1
522	AS	O	B	3090.00	29.77
522	AS	O	B	4091.00	5.01
522	AS	O	B	4234.00	1.73
522	AS	O	B	4124.00	5.92
522	AS	O	B	3424.00	25.18
522	AS	O	B	4227.00	0.69
522	AS	O	B	4187.00	1.23
522	AS	O	B	3697.00	16.15
522	AS	O	B	4074.00	9.81
522	AS	O	B	4138.00	2.9
522	AS	O	B	4071.00	5.43
522	AS	O	B	4156.00	4.34
522	AS	O	B	3805.00	12.61
522	AS	O	B	4011.00	8.16
522	AS	O	B	4097.00	4.46
522	AS	O	B	3051.00	34.13
522	AS	O	B	3826.00	12.47
522	AS	O	B	4226.00	2.22
522	AS	O	B	3164.00	29.5
522	AS	O	B	3089.00	31.68
522	AS	O	B	3983.00	8.88
522	AS	O	B	3960.00	11.09
522	AS	O	B	3713.00	17.11
522	AS	O	B	4157.00	3.13
522	AS	O	B	4052.00	5.78
522	AS	O	B	3920.00	11.48
522	AS	O	B	4092.00	1.99
522	AS	O	B	4183.00	0.39
522	AS	O	B	4124.00	4.53
522	AS	O	B	3926.00	9.89
522	AS	O	B	4055.00	6.61
522	AS	O	B	3476.00	22.1
522	AS	O	B	4190.00	1.72
522	AS	O	B	3502.00	23.68
522	AS	O	B	3946.00	9.19
522	AS	O	B	3598.00	19.47
522	AS	O	B	3922.00	13.63
522	AU	O	B	3686	22.38
522	AU	O	B	4071	14.05
522	AU	O	B	4079	17.34
522	AU	O	B	4294	8.46
522	AU	O	B	4387	1.95
522	AU	O	B	4335	4.44
522	AU	O	B	4033	14.74
522	AU	O	B	3263	31.69
522	AU	O	B	4268	9.06
522	AU	O	B	4333	3.59
522	AU	O	B	4293	5.97
522	AU	O	B	4359	2.05

522	AU	O	B	4304	6.42
522	AU	O	B	4319	9.14
522	AU	O	B	4323	4.83
522	AU	O	B	4264	7.65
522	AU	O	B	3701	27.92
522	AU	O	B	4343	4.51
522	AU	O	B	4164	10.35
522	AU	O	B	4230	8.73
522	AU	O	B	3827	24.59
522	AU	O	B	4226	10.38
522	AU	O	B	4262	8.42
522	AU	O	B	3955	18.75
522	AU	O	B	3866	22.33
522	AU	O	B	4397	2.89
522	AU	O	B	4364	4.98
522	AU	O	B	3434	34.03
522	AU	O	B	4262	9.76
522	AU	O	B	4279	6.99
522	AU	O	B	3947	18.75
522	AU	O	B	4083	14.01
522	AU	O	B	3926	20.25
522	AU	O	B	4316	5.6
522	AU	O	B	4270	8.02
522	AU	O	B	4400	1.22
522	AU	O	B	4273	8.12
522	AU	O	B	4268	7.09
522	AU	O	B	4238	6.54
522	AU	O	B	4050	15.65
522	AU	O	B	3685	24.55
522	AU	O	B	4341	5.47
522	AU	O	B	4265	5.62
522	AU	O	B	4233	9.8
522	AU	O	B	4142	11.81
522	AU	O	B	4296	5.66
522	AU	O	B	4025	18.29
522	AU	O	B	4398	2.16
522	AU	O	B	4107	14.06
522	AU	O	B	3890	19.65
522	AU	O	B	3921	15
522	AU	O	B	4348	3.88
522	AU	O	B	3501	30.02
522	AU	O	B	3888	23.87
522	AU	O	B	4083	13.58
522	AU	O	B	3464	30.77
522	AU	O	B	3433	32.26
522	AU	O	B	3849	19.87
522	AU	O	B	4218	8.63
522	AU	O	B	3678	28.74
522	AU	O	B	3827	20.79
522	AU	O	B	4293	5.07
522	AU	O	B	4112	13.55
522	AU	O	B	4039	18.01
522	AU	O	B	4187	11.96
522	AU	O	B	3423	33.16
522	AU	O	B	4275	10.19
522	AU	O	B	4096	12.81
522	AU	O	B	3924	19.58
522	AU	O	B	4210	10.42
522	AU	O	B	4125	14.36
522	AU	O	B	3961	17.18
522	AU	O	B	4116	13.74
522	AU	O	B	4096	14.46
522	AU	O	B	4222	7.31
522	AS	N	B	1859	58.12
522	AS	N	B	3025	32.22
522	AS	N	B	1834	57.34
522	AS	N	B	1815	57.8
522	AS	N	B	1812	58.55
522	AS	N	B	1670	63.11
522	AS	N	B	2205	49.15
522	AS	N	B	2634	42.38
522	AS	N	B	2378	45.38
522	AS	N	B	1886	58.28
522	AS	N	B	2106	53.21
522	AS	N	B	1739	59.85
522	AS	N	B	2757	39.01
522	AS	N	B	2264	50.69
522	AS	N	B	1465	63.7
522	AS	N	B	1770	59.36
522	AS	N	B	1282	70.81
522	AS	N	B	2027	54.27
522	AS	N	B	1271	70.6
522	AS	N	B	2002	54.49
522	AS	N	B	2428	44.49
522	AS	N	B	1799	58.23
522	AS	N	B	1988	54.97
522	AS	N	B	1816	58.84
522	AS	N	B	2292	47.03
522	AS	N	B	2226	50.31
522	AS	N	B	1609	63.43
522	AS	N	B	1516	64.52
522	AS	N	B	2230	50.6

522	AS	N	B	2331	46.21
522	AS	N	B	2330	47.6
522	AS	N	B	2251	49.95
522	AS	N	B	2171	50.07
522	AS	N	B	1992	53.87
522	AS	N	B	2205	49.68
522	AS	N	B	2678	40.65
522	AS	N	B	1887	56.49
522	AS	N	B	2075	53.98
522	AS	N	B	2116	51.51
522	AS	N	B	2257	47.85
522	AS	N	B	2699	41.96
522	AS	N	B	1168	73.52
522	AS	N	B	1714	61.63
522	AS	N	B	984	76.74
522	AS	N	B	3101	30.08
522	AS	N	B	1900	57.29
522	AS	N	B	2142	53.01
522	AS	N	B	1859	58.29
522	AS	N	B	2172	50.82
522	AS	N	B	1767	58.99
522	AS	N	B	1772	58.44
522	AS	N	B	1663	62.56
522	AS	N	B	2154	52.24
522	AS	N	B	1561	63.82
522	AS	N	B	1737	60.49
522	AS	N	B	1286	68.79
522	AS	N	B	1881	57.07
522	AS	N	B	1597	64.66
522	AS	N	B	1802	58.63
522	AS	N	B	2438	46.28
522	AS	N	B	1818	57.81
522	AS	N	B	2122	50.45
522	AS	N	B	1993	55.7
522	AS	N	B	1943	56.53
522	AS	N	B	1427	64.43
522	AS	N	B	1439	65.53
522	AS	N	B	1620	63.17
522	AS	N	B	1403	69.06
522	AS	N	B	1312	68.7
522	AS	N	B	2179	51.93
522	AS	N	B	1793	58.95
522	AS	N	B	1570	64.23
522	AS	N	B	1417	66.3
522	AS	N	B	2008	54.18
522	AS	N	B	1701	60.26

522	AU	N	B	1908	57.7
522	AU	N	B	2030	54.63
522	AU	N	B	1755	58.92
522	AU	N	B	1955	55.92
522	AU	N	B	2015	57.63
522	AU	N	B	1735	60.73
522	AU	N	B	1525	65.53
522	AU	N	B	2149	52.83
522	AU	N	B	2273	49.58
522	AU	N	B	2498	45.2
522	AU	N	B	1774	59.19
522	AU	N	B	2335	49.03
522	AU	N	B	1926	56.49
522	AU	N	B	1577	64.73
522	AU	N	B	1526	64.94
522	AU	N	B	1466	66.65
522	AU	N	B	2259	50.89
522	AU	N	B	1604	64.23
522	AU	N	B	1427	68.41
522	AU	N	B	2149	52.25
522	AU	N	B	2017	57.52
522	AU	N	B	1261	71.23
522	AU	N	B	2231	51.07
522	AU	N	B	1272	72.31
522	AU	N	B	1760	60.27
522	AU	N	B	1674	62.77
522	AU	N	B	1754	62.86
522	AU	N	B	2077	54.33
522	AU	N	B	2098	54.36
522	AU	N	B	1995	57.19
522	AU	N	B	1360	68.38
522	AU	N	B	1690	61.94
522	AU	N	B	1938	56.62
522	AU	N	B	1214	72.41
522	AU	N	B	2156	53.53
522	AU	N	B	1613	63.11
522	AU	N	B	2377	48.25
522	AU	N	B	2757	40.91
522	AU	N	B	2665	41.18
522	AU	N	B	971	78.16
522	AU	N	B	1292	71.25
522	AU	N	B	1979	55.48
522	AU	N	B	2333	50.05
522	AU	N	B	2054	56.08
522	AU	N	B	2294	49.68
522	AU	N	B	2644	40.44

522	AU	N	B	1898	58.34
522	AU	N	B	2468	45.71
522	AU	N	B	2156	53.25
522	AU	N	B	2454	46.34
522	AU	N	B	1495	65.26
522	AU	N	B	1539	66.1
522	AU	N	B	1296	70.72
522	AU	N	B	1568	65.2
522	AU	N	B	1238	72.19
522	AU	N	B	1330	70.59
522	AU	N	B	1901	58.61
522	AU	N	B	1412	67.71
522	AU	N	B	1909	57.3
522	AU	N	B	2170	53.87
522	AU	N	B	874	78.62
522	AU	N	B	2403	47.24
522	AU	N	B	2490	46.08
522	AU	N	B	2337	49.36
522	AU	N	B	1174	72.72
522	AU	N	B	1624	62.58
522	AU	N	B	2161	51.7
522	AU	N	B	1464	67.77
522	AU	N	B	1383	68.98
522	AU	N	B	1884	59.66
522	AU	N	B	1883	57.17
522	AU	N	B	1316	72.47
522	AU	N	B	1647	62.89
522	AU	N	B	1880	56.29
522	AU	N	B	1585	65.61
522	AS	O	U	4201	0
522	AS	O	U	4190	0
522	AS	O	U	4196	0
522	AS	O	U	4237	0
522	AS	O	U	4232	0
522	AS	O	U	4270	0
522	AS	O	U	4259	0
522	AS	O	U	4248	0
522	AS	O	U	4236	0
522	AS	O	U	4200	0
522	AS	O	U	4226	0
522	AS	O	U	4181	0
522	AS	O	U	4308	0
522	AS	O	U	4201	0
522	AS	O	U	4258	0
522	AS	O	U	4230	0
522	AS	O	U	4247	0

522	AS	O	U	4257	0
522	AS	O	U	4215	0
522	AS	O	U	4200	0
522	AS	O	U	4229	0
522	AS	O	U	4178	0
522	AS	O	U	4265	0
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522	AS	O	U	4171	0
522	AS	O	U	4240	0
522	AS	O	U	4228	0
522	AS	O	U	4241	0
522	AS	O	U	4187	0
522	AS	O	U	4196	0

522	AS	O	U	4253	0
522	AS	O	U	4222	0
522	AS	O	U	4211	0
522	AS	O	U	4200	0
522	AS	O	U	4220	0
522	AS	O	U	4224	0
522	AS	O	U	4246	0
522	AS	O	U	4262	0
522	AS	O	U	4229	0
522	AS	O	U	4271	0
522	AS	O	U	4190	0
522	AS	O	U	4252	0
522	AU	O	U	4427	0
522	AU	O	U	4398	0
522	AU	O	U	4414	0
522	AU	O	U	4423	0
522	AU	O	U	4427	0
522	AU	O	U	4410	0
522	AU	O	U	4405	0
522	AU	O	U	4411	0
522	AU	O	U	4429	0
522	AU	O	U	4399	0
522	AU	O	U	4423	0
522	AU	O	U	4379	0
522	AU	O	U	4370	0
522	AU	O	U	4410	0
522	AU	O	U	4326	3.52
522	AU	O	U	4401	0
522	AU	O	U	4419	0
522	AU	O	U	4413	0
522	AU	O	U	4400	0
522	AU	O	U	4397	0
522	AU	O	U	4412	0
522	AU	O	U	4444	0
522	AU	O	U	4407	0
522	AU	O	U	4416	0
522	AU	O	U	4398	0
522	AU	O	U	4438	0
522	AU	O	U	4398	0
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522	AU	O	U	4426	0
522	AU	O	U	4408	0
522	AU	O	U	4432	0
522	AU	O	U	4439	0
522	AU	O	U	4412	0
522	AU	O	U	4417	0

522	AU	O	U	4392	0
522	AU	O	U	4400	0
522	AU	O	U	4413	0
522	AU	O	U	4406	0
522	AU	O	U	4429	0
522	AU	O	U	4415	0.14
522	AU	O	U	4415	0
522	AU	O	U	4428	0
522	AU	O	U	4408	0.05
522	AU	O	U	4414	0
522	AU	O	U	4388	0
522	AU	O	U	4430	0
522	AU	O	U	4436	0
522	AU	O	U	4395	0
522	AU	O	U	4421	0
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522	AU	O	U	4402	0
522	AU	O	U	4419	0
522	AU	O	U	4422	0
522	AU	O	U	4422	0
522	AU	O	U	4427	0
522	AU	O	U	4406	0
522	AU	O	U	4415	0
522	AU	O	U	4397	0
522	AU	O	U	4431	0
522	AU	O	U	4385	0
522	AU	O	U	4408	0.52
522	AU	O	U	4394	0
522	AU	O	U	4404	0
522	AU	O	U	4416	0
522	AU	O	U	4396	0
522	AU	O	U	4416	0
522	AU	O	U	4406	0
522	AU	O	U	4399	0
522	AU	O	U	4406	0
522	AU	O	U	4406	0
522	AU	O	U	4384	0
522	AU	O	U	4432	0
522	AU	O	U	4404	0
522	AU	O	U	4394	0
522	AU	O	U	4409	0
522	AS	N	U	3337	23.86
522	AS	N	U	4210	0.88
522	AS	N	U	3910	12.21
522	AS	N	U	4237	2.66
522	AS	N	U	4132	6.47

522	AS	N	U	3856	13.94
522	AS	N	U	3663	15.09
522	AS	N	U	3676	16.22
522	AS	N	U	4278	1.08
522	AS	N	U	3792	13.81
522	AS	N	U	3651	16.71
522	AS	N	U	3910	10.07
522	AS	N	U	3562	17.07
522	AS	N	U	3865	13.2
522	AS	N	U	4198	2.3
522	AS	N	U	4251	1.81
522	AS	N	U	3959	9.32
522	AS	N	U	3614	18.12
522	AS	N	U	4316	
522	AS	N	U	4092	6.76
522	AS	N	U	4117	6.27
522	AS	N	U	3826	13.81
522	AS	N	U	3923	10.07
522	AS	N	U	3196	27.11
522	AS	N	U	4130	3.73
522	AS	N	U	3344	23.87
522	AS	N	U	4220	3.05
522	AS	N	U	3537	20.55
522	AS	N	U	4150	5.25
522	AS	N	U	3769	13.95
522	AS	N	U	4228	2.97
522	AS	N	U	3993	9.26
522	AS	N	U	3671	16.66
522	AS	N	U	4300	0.01
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Vita

Captain Kirk B. Pettingill graduated from Duval High School in Lanham, Maryland in 1982. After two years of undergraduate studies he enlisted in the USAF in January of 1985. Capt Pettingill spent over nine years as an Electronic Warfare Technician. His first assignment was to Barksdale AFB LA for a year and then PCSed to Anderson AFB, Guam. After a three-year tour in Guam he PCSed to Hurlburt Field, FL. During his tour at Hurlburt Field as an instructor in his career field, Capt Pettingill finished his undergraduate degree in Electrical Engineering Technology.

In March of 1994, Capt Pettingill was commissioned after completion of Officers Training School. His first assignment was to the 1st Rescue Group (RG) at Patrick AFB, Fl. In June of 1997, Capt Pettingill accompanied the 1st RG on their move from Patrick AFB to Moody AFB GA. He served numerous positions while assigned to Moody AFB culminating in his service as the Squadron Maintenance Officer for the 68th Fighter Squadron (F-16's).

n August of 2001, he entered the Graduate Logistics Management program at the Air Force Institute of Technology. Upon graduation, he will be assigned to the Air Force Logistics Management Agency (AFLMA), Gunter Annex, Maxwell AFB AL.

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 074-0188*

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From – To)*
15-03-2003	Master's Thesis	Sept 2001– March 2003

4. TITLE AND SUBTITLE

AN ANALYSIS OF THE EFFICACY OF THE LOGISTICS COMPOSITE MODEL IN ESTIMATING MAINTENANCE MANPOWER PRODUCTIVE CAPACITY

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Pettingill, Kirk B., Captain, USAF

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)

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2950 P Street, Building 640
WPAFB OH 45433-8865

8. PERFORMING ORGANIZATION REPORT NUMBER

AFIT/GLM/ENS/03-11

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The Logistics Composite Model (LCOM) is the tool of choice for many MAJCOM's (ACC, USAFE, AFMC) in determining maintenance manpower requirements. The LCOM is a simulation program capable of modeling the manpower, equipment, supplies, and facilities required to conduct aircraft maintenance activities. Manpower studies conducted with the LCOM result in manpower estimates that end up in Unit Manning Documents (UMD) as "LCOM earned," authorized positions. This research effort focuses on whether the LCOM can also be used to determine maintenance manpower's current capacity.

Three different flying units at Cannon AFB, NM were modeled to determine if the LCOM, when programmed with historical data, would imitate the actual sortie production of those units that were realized during the previous annual flying period (FY2002).

Based on the analysis and results presented, the researcher concludes that the LCOM can be a viable tool for this purpose but recommends that a standard set of "best practices" be developed and implemented by LCOM analysts to standardize the methodology and improve the reliability of results.

15. SUBJECT TERMS

Logistics Composite Model (LCOM), Maintenance Manpower

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Stephen M. Swartz, Lt Col, USAF
U	U	U	UU	131	**19b. TELEPHONE NUMBER** *(Include area code)* (937) 255-6565, ext 4285 (stephen.swartz@afit.edu)

Standard Form 298 (Rev. 8-98)
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